Heating and Ventilating

For Engineers and Contractors Controlling the Design, Specification, Installation and Maintenance of Heating, Ventilating and Air Conditioning

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THIS MONTH'S COVER

The British Empire Building, located on the Fifth Avenue front of Radio City, New York, is air conditioned by means of a steam refrigeration system, steam being used for cooling as well as for heating. Opened May 1, the building houses displays of British-made products, as well as offices.

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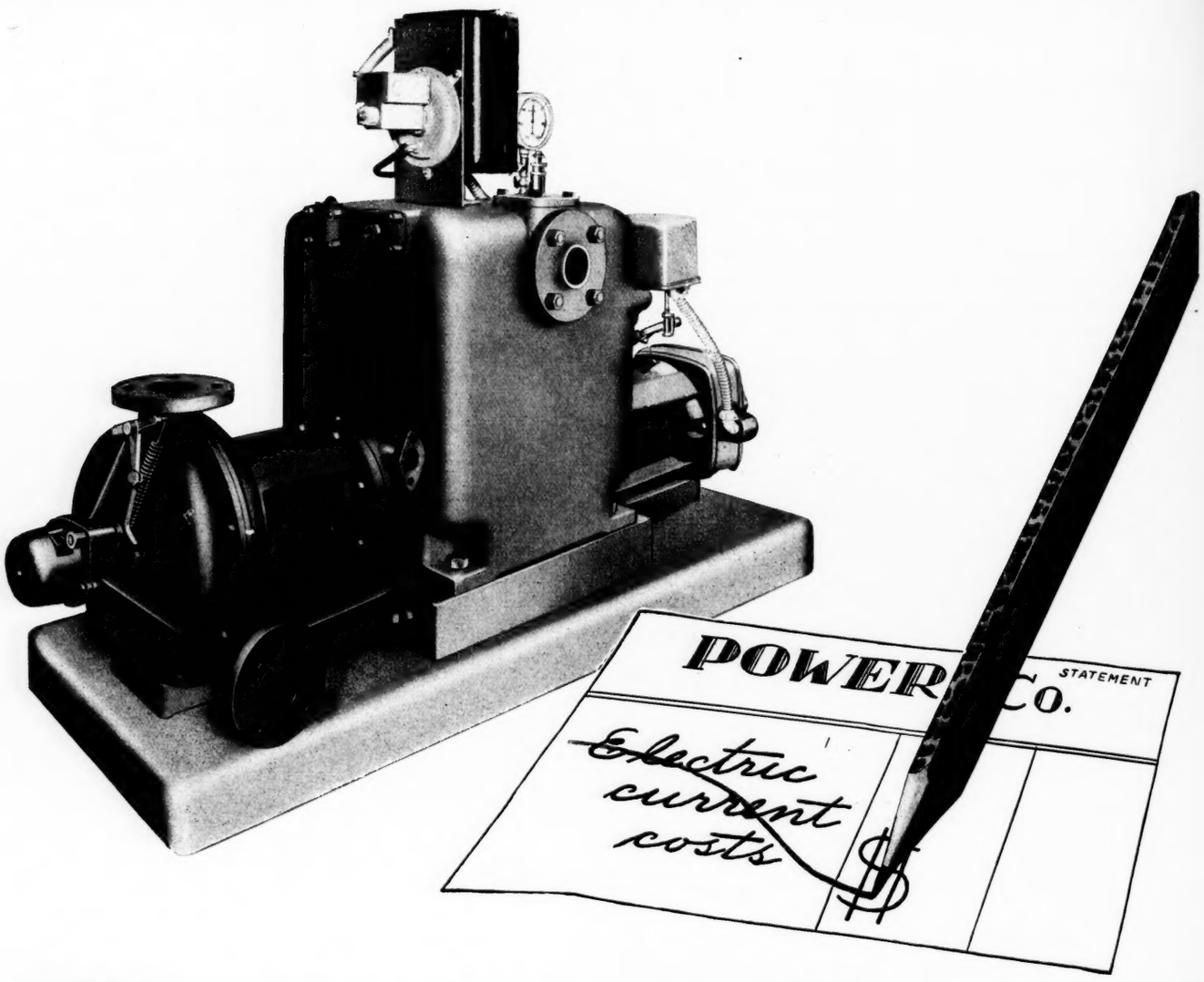

Why not cross out this expense?

Why not eliminate the one largest cost item in the operation of a return line heating pump, the electric current? The Jennings Vapor Turbine operates on steam directly from your heating mains, and returns that steam to the heating system with little heat loss.

This remarkable pump is driven by a newly developed vapor turbine which functions on a differential of only 5" of mercury, and on any type of vacuum heating system, regardless of type of steam control. It is equally efficient on low pressure steam, high pressure steam thru reducing valve, or on street steam. It makes no difference whether the system is run above or below atmosphere, because the turbine functions on the difference between the inlet and exhaust, not on a given pressure above atmosphere.

But this saving in operating cost is not the only advantage offered by the new Vapor Turbine Jennings Heating Pump. This equipment gives you safety in your heating system. It is independent of possible current failures. It functions as long as there is steam in the heating system, assuring constant and reliable vacuum and boiler return.

Further, the fact that its operation is continuous means that the system is kept at the maximum of its operating efficiency at all times.

There are other points about this pump that it will pay you to investigate. They are covered in Bulletin 203. We need only your name and address to send you a copy.

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The Present Situation in Air Conditioning Equipment

Trends in air conditioning equipment, particularly that for small and medium-sized buildings, with a discussion of self-contained room coolers and steam refrigeration.

SOME nine months ago, equipment suitable for use with air conditioning for small to medium-sized buildings was described and summaries were made (see pages 67 and 68, HEATING AND VENTILATING, October, 1932). Since that time interesting developments have taken place. The following summary gives the situation as of approximately July 1, 1933, and describes in some detail the more outstanding changes in equipment which have come about.

More Manufacturers Attracted

The names of 108 manufacturing firms can now be identified as offering equipment which they describe as "air conditioning" and which would find logical use in buildings of the kind we are considering. Confusion about the correct use of the words is still present, no improvement having been noted in this respect. Consequently, the apparatus still varies all the way between one function to six or seven functions.

Since 87 names were identified last fall, there has been an increase of 21 in the intervening months. The increase is not net, however, for there have been some mortalities. A notable and significant point is that only one or two of the newcomers are firm names long identified with heating and ventilating. In other words the expansion is being done by firms either new or having been in business in other lines. Of interest, too, is the entrance of the two largest electrical manufacturers in the country who have come in with package type of products which they appear to expect to merchandise. So also has the most prominent of the old-established refrigerating machinery makers entered a line of products of almost similar character.

Equipment Trends

Probably the best over-all view can be had by arranging the items into a table. Setting this up beside a similar one for last October shows readily what has taken place in the equipment side of the picture.

Just a glance at the table shows that the greatest number of new items has been added to the steam and hot water group, 32 products of all kinds having been added while but five were added in the warm-air group.

	Oct. 1932	June 1933	Net Change
WARM-AIR GROUP			
Integral type plants	11	12	+1
Units to-be-added plants	22	22	0
Separate fabricated units	12	16	+4
STEAM AND HOT WATER GROUP			
Permanent direct cabinet units	20	28	+8
Permanent wall built or flush-mounted	17	24	+7
Portable direct units (ice-cooled)	13	12	—1
Portable direct units (humidifying, etc.)	9	16	+7
Unit conditioners (direct or indirect)	8	11	+3
Indirect units (basement or central)	12	18	+6

Warm-Air Equipment

The small number of new products brought out by those using air as the circulating medium is further emphasized by the fact that direct replies from the majority of those listed last fall stated that they had not only brought out no new equipment but that they had made no material changes in their old. It thus appears that this group proposes to stand pat on its present products. The only new integral-type plant is oil-fired. The four new fabricated units are all of the washer-blower-filter type.

The few changes reported by established makers of warm-air equipment consisted almost altogether of refinements or of making additional optional equipment available for original installation. One reported a new type of filter, another a rearrangement of filters, another added humidity control, two made provision for inserting a dry-type cooling coil if desired, while one changed from a propeller-type fan to a centrifugal. Several announced redesigns and additions to their lines. Few reported contemplating any important changes in the near future.

Equipment for Radiator Systems

This is distinctly not the case with those who use steam or hot water for heating. Developments are coming along rapidly in this group. Not only did most of the new products appear here but most of the new-coming manufacturers were attracted to this field.

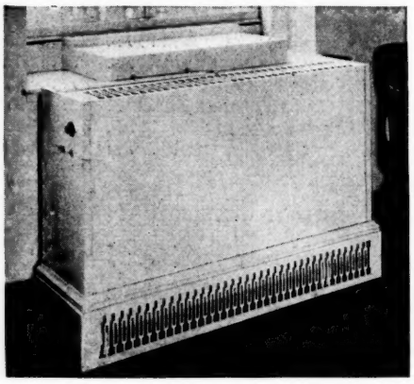
Just why development work and announcement of new products should have so nearly stopped in the one case and gone along rapidly in the other is not clear. General business conditions are no doubt responsible

to some extent. In a number of cases the entry of new manufacturers marks a diversification of their lines and is financed out of past earnings, being regarded as a timely undertaking in order that they may enter the field while it is still new and that they may perfect organizations and products against the day when business picks up. To do this under present circumstances requires adequate capital, among other things. Many of the air-using group are local operators who have not piled up surpluses. On the other hand the warm-air group may feel that their products are now in good shape and need little additional development in order to appeal. Moreover, being established in their market they may feel that the present is not a promising time to bring out their new products. At any rate the past few months have certainly seen a marked reversal of the trend of two years ago when warm-air conditioning units were appearing most rapidly.

This subject has another interesting angle. Two

(Continued on Page 12)

Self-Contained Room Coolers



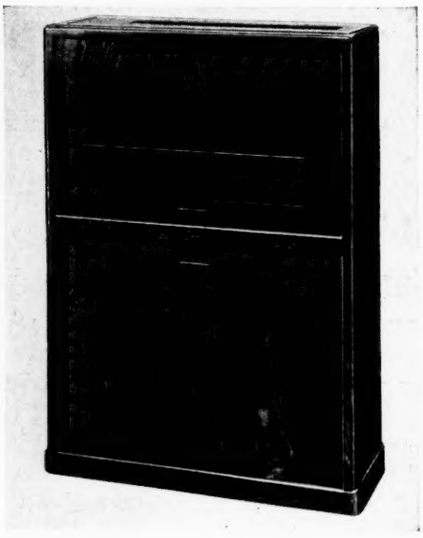
Campbell Metal Window Corp. New York, N. Y.

Trade Name: Model C.

Includes: Filter, humidifier, cooling and heating coi's of copper extended surface, double centrifugal fan on both ends of motor, 2-cylinder compressor, thermostatic control for heating.

Sizes and Capacities: 1-hp. compressor motor, humidifier evaporates 1 pt. per hr., 1/20-hp. fan motor, cabinet 55 in. wide, adjustable height from 29 in. to 36 in., cooling capacity 8000 B.t.u. per hr., heating capacity 50 sq. ft. steam radiator. Weight 650 lb.

Remarks: Freon refrigerant, Maxim silencer, air discharge from top, outside air intake in top back for connection to window, recirculating air intake on bottom. Two copper tubes to drain. Ivory finish for refinishing. Connections required in field: to steam line, power line (for compressor motor), lighting circuit (for fan motor). Humidifier of immersion type. Cabinet is permanently located. Maker also offers Model J, portable, rubber-wheel-mounted unit for cooling only.



Carrier Products Corp. Newark, N. J.

Trade Name: Carrier Room Weathermaker.

Includes: Two cylinder compressor for cooling, two cooling coils, centrifugal blower, double, on both ends of motor. Bronze wool filter, manual or semi-automatic controls.

Sizes and Capacities: One size, 59 in. high, 42 in. wide and 17 in. deep. Cooling capacity 1 ton. Compressor motor, 1 hp. Fan motor, 1/50 h.p. Weight 850 lb.

Remarks: Sound insulated, metal casing finished in dark walnut. Unit can humidify in winter. Freon or methyl chloride refrigerant. Air discharge vertical, return air intake front middle. Requires field connection to city water supply, power circuit, and drain.

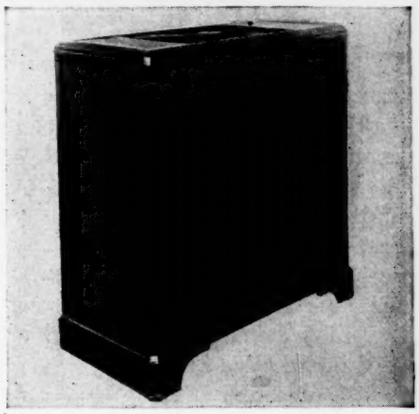
General Electric Co. Schenectady, N. Y.

Trade Name: Portable Unit Cooler Type AE-1.

Includes: Compressor, coils for cooling, blower, manual control.

Sizes and Capacities: 43 in. long, 33 in. high, and 16 in. deep. Cooling capacity, 4000 B.t.u. per hr. Compressor motor, ½ hp. Weight 500 lb. Fan motor, 1/20 hp. Single cylinder compressor.

Remarks: Extended surface cooling coils, multivane blower, freon refrigerant, rubber-tired portable type, finished in gray for refinishing, air discharge at top, air intake at bottom back. Connection to drain and water through flexible hose, furnished. Field connections required for power and for hose. Maker also offers permanent unit for heating as well as cooling.



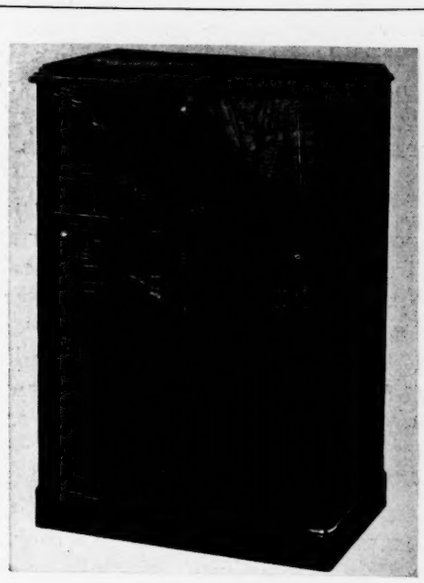
Ilg Electric Ventilating Co. Chicago, Ill.

Trade Name: Ilg Spot Kooler.

Includes: Twin compressor and low-side unit in bottom of wood cabinet, double cooling coil, self-cooled propeller fan.

Sizes and Capacities: One size, 48 in. high, 30 in. wide and 18 in. deep. Cooling capacity, 0.55 ton. Compressor, ½ hp., 100-125 volts, single phase a.c. or d.c. Weight 350 lb.

Remarks: Uses methyl chloride as refrigerant. Horizontal air discharge, return air from rear. Requires connection to lighting circuit and water supply and drain. Not designed for heating in winter. Walnut veneer finish. Special electrical connector and rubber tubing furnished with unit.



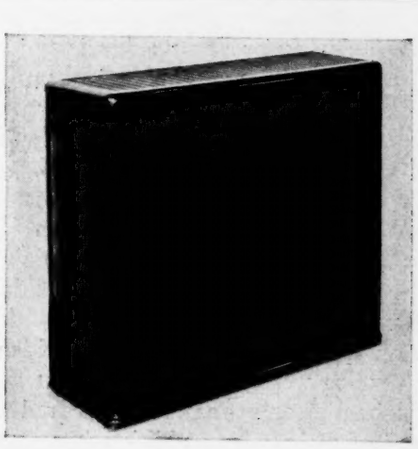
Scott-Newcomb, Inc. St. Louis, Mo.

Trade Name: Pioneer.

Includes: Metal casing, fin-type cooling coil, rotary compressor, manual or semi-automatic controls, centrifugal blower.

Sizes and Capacities: One size, cooling capacity, ½ ton. 1/3-hp. motor operates both compressor and fan. Freon used as refrigerant. Connections to water supply for condenser of ¼-in. copper tubing or 3/16-in. silk covered hose. Height 31 in., width 34 in., depth 11 in. Weight 150 lb.

Remarks: Does not heat or humidify in winter. Air discharge at top, recirculated air intake at bottom. Can take small amount of outside air. Walnut finish. Can be supplied on wheels, optional. Field connections, to lighting circuit, water, and to drain or condensate pan.



years ago when the warm-air units were appearing so rapidly there were but few available which used steam or hot water. In spite of what obviously could be done, it seemed that little headway was being made in the appearance of actual equipment. While the warm-air group had products and were finding business, those whose interests lay in steam and hot water had little to offer. Most prospective makers were perhaps engaged in development and surveying of potentials. The recent activity probably reflects the result of this groundwork. With the late announcements of new equipment, the steam and hot water group now has plenty of units available and is well set to take advantage of prospective business.

With all these announcements of equipment it is of interest to examine them by groups.

Humidifying Equipment

Of all the equipment, the humidifier by all means took the palm. These devices which are almost always distinctly of the single-function variety continued to hold their place as the item which seems to appeal most to makers. No less than 14 separate and distinct makes appeared in the short space of 10 months, sponsored by as many firms. One was of the ceiling type; two were of the economizer type for installation in the path of the chimney gases; 6 were portable for floor or table mounting; the remainder were either of the permanently-installed direct-room cabinet type or for floor mounting. One combined heater and humidifier of cabinet type also made its appearance. These new additions, together with those already on the market, raises the total of these units now available to certainly not less than 40 distinct makes.

When it is recalled that most of the multi-function units also include a device for humidification, the appearance of so many humidifiers as separate devices means that their large field of application is almost certain to be in existing buildings. In view of this and the great number already on the market it is difficult to understand why humidifying devices continue to carry such an appeal to manufacturers who are interested in finding some product with which to enter the air conditioning market.

Next to the humidifier in point of interest is the portable room cooler using ice. It must be remembered that these coolers sprang up during the past year and a half and that no less than 13 had put in an appearance by last fall. Most of them have thus passed through but one season and are now only entering on their second. Since last October we have a record of but one additional line of these coolers being brought out. As these months were off-season for cooling apparatus, the lack of announcements might not occasion surprise. When, however, it is considered that the months of May and June have passed without any new designs being brought out it is evident that the ice coolers which were on the market last summer will in general be the only ones to be offered this year. It seems likely that few additional new portable iced coolers will be announced until their market is more thoroughly tested. We are informed that two of those on the market last year are now withdrawn.

Cooling Equipment

A third group of units is of enough importance in numbers to warrant mentioning. Last year there were only a few makers who offered a free-standing direct cabinet unit into which refrigeration equipment was built. The other cabinet units were intended to permit attaching to remotely located refrigeration machines, if desired. In other words, mechanical cooling was not definitely built into the unit itself. In the intervening 10 months five manufacturers have announced units of this kind.

This movement can be better appreciated when we consider that most of the room cabinets available last fall were offered by firms whose background of interest was mainly heating rather than cooling. In the main they were not themselves makers of refrigeration machinery. To them a cabinet unit equipped for attaching to refrigeration, if wanted, was quite adequate. The user could arrange for cooling when and if wanted and the heating was the important item. This reasoning did not line up with the ideas of those whose chief interest lay on the refrigeration side. To them it was more important that refrigeration be definitely provided, with the heating function as something of a side interest. What would be more natural than that when their units appeared they would insure the incorporation of cooling into the plan by building it in? Viewed in this way the self-contained cabinet is a logical development and its appearance in such numbers in the past few months reflects the entrance of the refrigeration machinery makers into the field with products suitable for use in small to medium-sized spaces. It means that we now have a wide range of cooling cabinets which can also be used for heating, as well as heating cabinets which can be used for cooling.

A complete picture of the present equipment is not at hand unless we call attention to the changes made by those whose products were listed last fall. While some of them have announced new equipment, most have contented themselves with their older products, incorporating refinements in details in some cases. One has added a self-contained refrigerating room cabinet; another has added a ceiling-type dry coil unit; a third has expanded his line greatly by adding a series of cabinets and basement units. Notable, too, is the addition of a fabricated unit using an aluminum finned coil.

Among instruments which have appeared are two humidity control devices and several electrically-operated valves for use in connection with air conditioning apparatus. Other items include a railroad car unit and a window filter box, as well as several filtering redesigns and improvements. These are in addition to the several devices described later in this article.

Among the accessory apparatus which has appeared is an air mixing cabinet. This is for use where the maintained conditions are exacting or vary from room to room in a given building. Air conditioned at a central plant is led to the mixing box and there mixed with room air, heated, or cooled as required, and de-

livered into the room. Controls located at the box permit the quantities and operations to be individually controlled.

Cabinets with Refrigerating Machinery Built-In

With this general outline of what has happened to equipment in late months we can give closer attention to some of the individual items and ideas. As space will not permit going into each in detail it is necessary to select those which are either different from usual practice, are new, or newly applied. As already noted most of the recent developments have been on the side of cooling rather than heating. Refrigerating equipment has been emphasized and all the items selected for treatment fall under this head.

The increase in the number of cabinet units with built-in refrigeration has already been noted. In addition to this, steam refrigeration has been made available in units of small enough size and using low enough steam pressures so that its use in small to medium-sized buildings is now a practical reality, and a cabinet operating on the reversed cycle has been brought out. All of these are of enough present or prospective importance so that attention is warranted.

As equipment using the compression system without reversal is most numerous, and probably best known, we will start with it. Room cabinets have been either for connection to refrigeration remotely located, as shown in Fig. 1, or for use in both winter and summer by using the plan shown in Fig. 2. The plan of Fig. 1 permits cooling only and a separate heating device in the room is necessary. It requires piping on the site and a suitable location for the refrigeration machinery must be found. If the refrigerating machinery were built in the bottom of the cabinet itself, the field installation of the refrigeration piping would be minimized. The whole refrigeration plant could be sent to the site assembled and be ready for operation with a minimum of fitting and connecting. If, in addition, a second coil were placed in the cabinet it could be arranged for connection to steam or hot water piping. The cabinet would then be not only a cooling cabinet but could be used for heating as well. Filters and humidifiers could be added and the cabinet would be able to handle all the processes of air conditioning. This is substantially what has been done by one or two manufacturers. A typical diagram of such a plant is shown in Fig. 3. Most of the self-contained cooling cabinets, however, do not contain any heating arrangement. They are distinctly for summer operation only and are equipped with flexible water and electric connections. Mounted on rollers they are portable to a degree at least. In this respect they resemble the ice-cooled units and are competitive with them.

The importance of quiet-running cannot be overlooked, for the whole operating mechanism is in the room itself. This means that fan, motor, and compressor must all operate quietly.

Electric connections in the field are necessary. In order to make this practical the power requirement per unit must be kept within that permitted on lighting circuits as the installation of heavy wire and special circuits is usually prohibited by the owner's objection both to cutting and fitting and to cost. The current characteristics of the motors are therefore arranged for those suitable for lighting circuits. This, and the noise limitation, at present keep the unit sizes and capacities down to one ton or less (not more than 18,000 B.t.u.).

Water cooling for the condenser is used, and hence circulating water connections must be made. These can be either solid or flexible, with flexible tubes used for the portable types. Means are provided in some cases for putting into the circulating water the water condensed out of the air. Where this is done a separate drain connection is avoided.

The principal points about the five makes of self-contained cabinets are included in the listings on pages 10 and 11.

Self-Contained Basement Cabinets

The next piece of equipment to which attention is turned is the basement (or indirect) unit in which the compression refrigeration machinery is located in the bottom of the metal enclosure. The space under the coil and circulating fan is used to house the refrigeration machinery instead of locating it outside the unit. Fig. 5 illustrates such a unit as a part of a heating and cooling installation. While illustrated as being located in the basement, the unit could equally well be placed anywhere outside the space to be cooled (such as on the same floor but behind a partition) as shown in Fig. 4. Evidently, like the self-contained cabinet, its chief difference from the older plan is that the whole cooling equipment can be built in and a definite space is provided for it. Field erection of refrigeration piping is also reduced to a minimum with this arrangement.

Steam Refrigeration

Steam refrigeration has received increasing attention for some time. (See HEATING AND VENTILATING, February, 1933, pages 22-27, for a statement of the principle). A number of installations have been made in large buildings. Of late, this method of producing a supply of cold circulating water has been applied in small units. In Fig. 6 is shown diagrammatically a hook-up where this is used. It will be noted that the steam-cooling apparatus replaces the more widely known compression type of machine. The same boiler furnishes steam for heating and cooling.

The basement conditioning unit shown can equally well be located behind a partition on the same floor as the space to be conditioned. The cooling apparatus can also be used to supply cold circulating water to room cabinets if desired.

Reversed Refrigeration

Reversed refrigeration for heating with the same apparatus used for cooling is an old idea. It has, however, not been advanced commercially to any extent until recent years. It has interesting heat and energy

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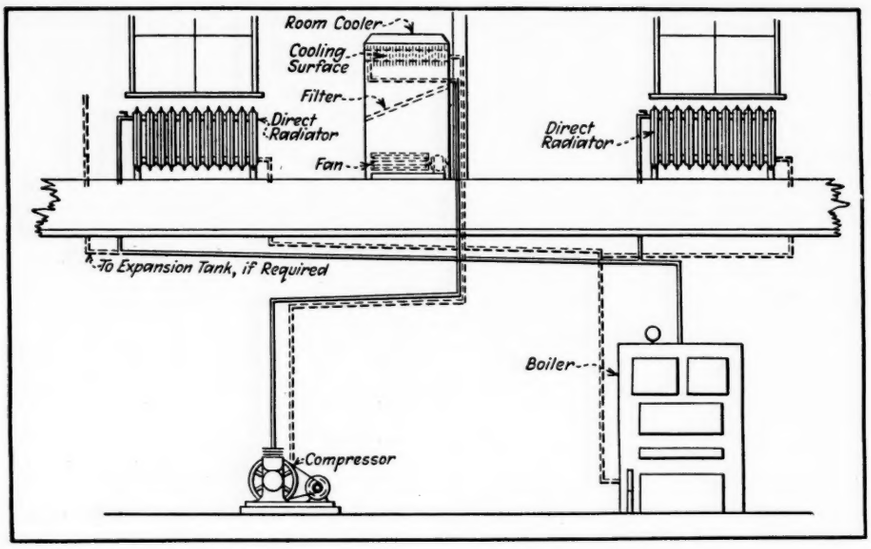


Fig. 1. Room cooler with remotely located compressor. In this type installation separate piping is used for the cooling, the heating piping being separate and connected to the usual radiator.

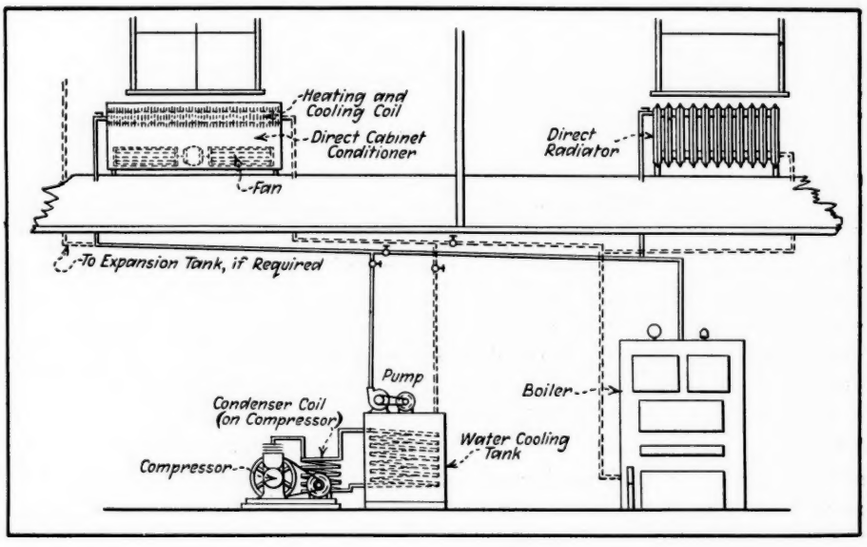


Fig. 2. Direct radiator and direct conditioner plant. Combined piping for the heating and cooling is possible and the conditioner unit in the room replaces the ordinary radiator.

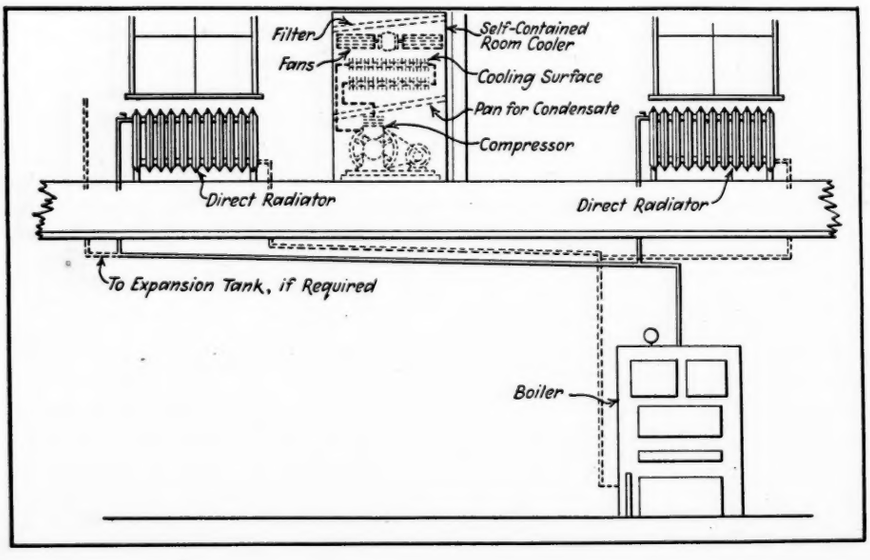
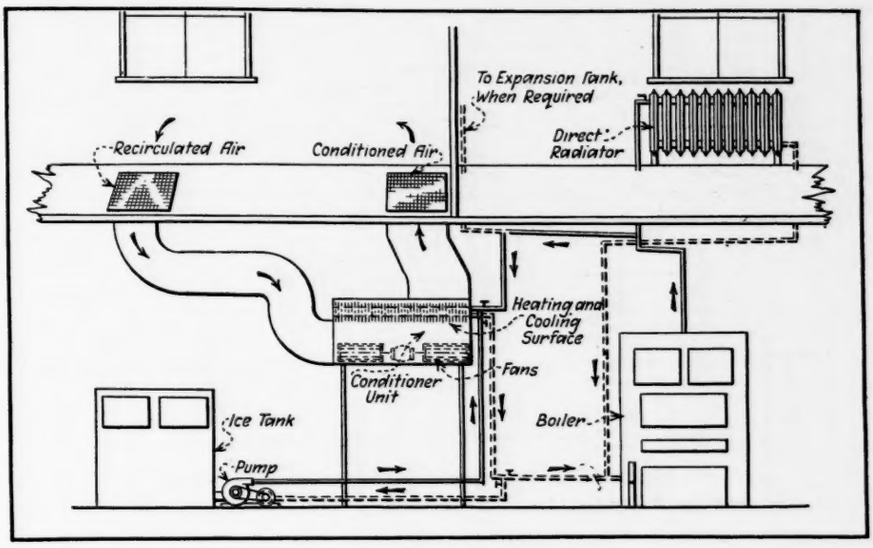


Fig. 3. Direct radiator and self-contained room cooler. The usual type radiator is used for heating, the room cooler being more or less portable and entirely self-contained, housing the compressor as well as the heat exchange surface, fan, and filter.

Fig. 4. Indirect conditioner plant used for heating in the winter and cooling for the summer, the conditioner unit located in the basement connected to either a compressor or an ice tank for summer cooling and to the boiler for winter heating.



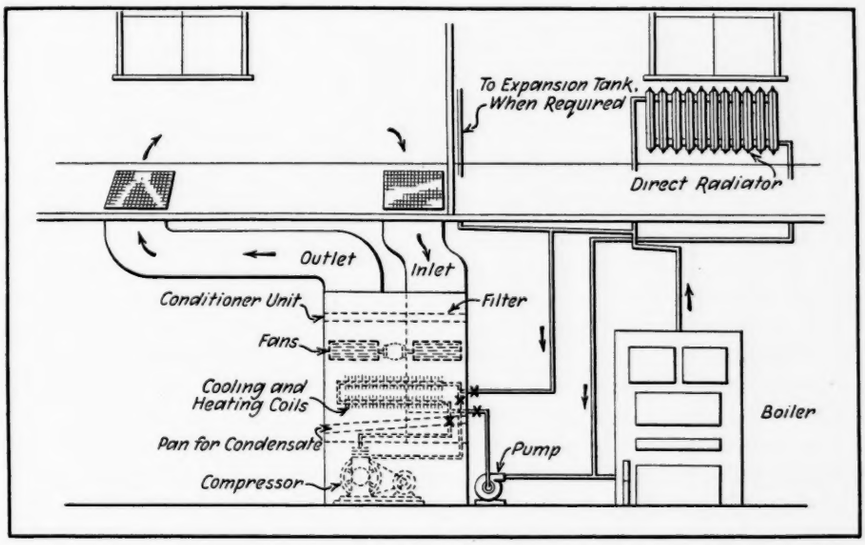
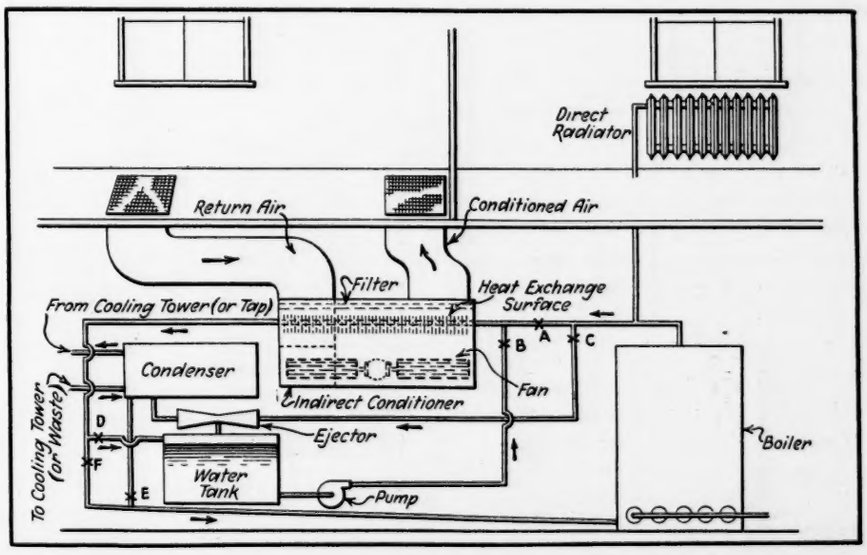


Fig. 5. Self-contained indirect conditioner unit similar to Fig. 4, except that the compressor is contained in the conditioner unit.

Fig. 6. Indirect conditioner using steam refrigeration. The boiler operates the year round supplying steam for cooling in summer and for heating in winter. For summer use valves A and F are closed, B, C, D, and E being open. In the winter, valves A and F are open and valves B, C, D, and E are closed.



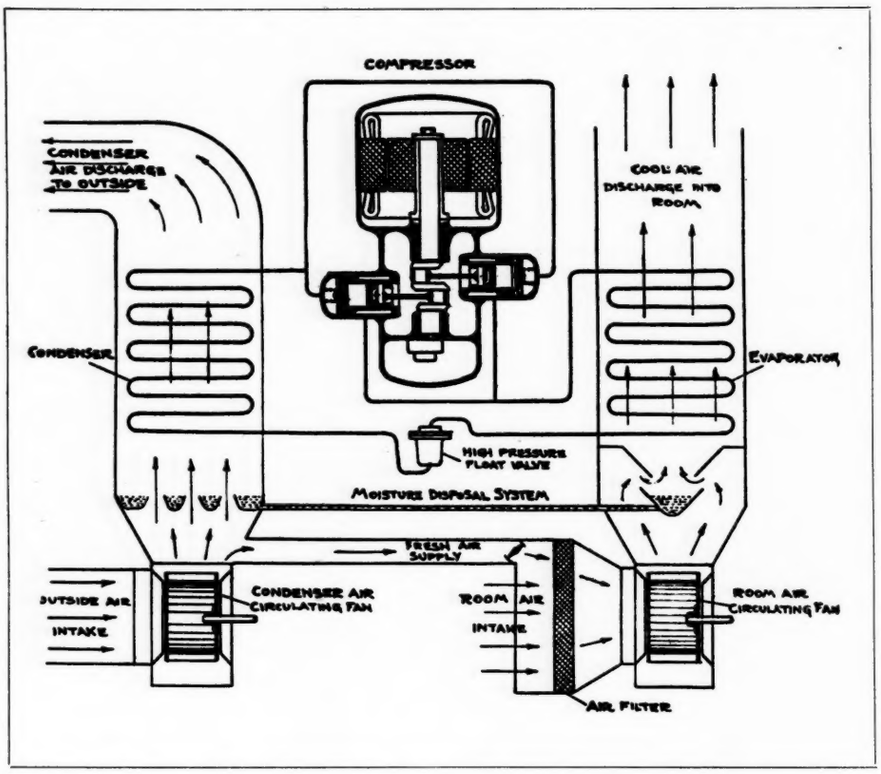


Fig. 7. Schematic diagram showing reversed refrigeration cycle as employed in room cooler.

relationships which have been repeatedly discussed and analyzed. (See HEATING AND VENTILATING, September, 1931).

Because of this background the appearance of a compact room cabinet using this principle calls for description in summarizing new equipment for use in small to medium-sized rooms. Fig. 8 shows the exterior of the cabinet and it will be noted that it looks like other cabinets from the outside. Various designs of exteriors are available but all are approximately 56 in. long, 43 in. high, and 22 in. deep. The depth is thus somewhat greater than the usual room unit. At present the cabinets are offered using freon as the refrigerant and in a capacity of 1½ tons of cooling effect, or 18000 B.t.u. per hr. They circulate 600 c.f.m. and are said to be of sufficient capacity to handle the cooling in a room of approximately 5000 cu. ft. Increased capacity is obtained by multiple installation. Fans can be operated independent of the compressor which is under automatic control. The compressor is of the two-cylinder opposed vertical shaft type directly connected to a 2-hp. vertical shaft motor, operating at a synchronous speed of 1800 r.p.m.

Installation of the cabinet is different from that required with cabinets of more familiar type. Since air is used for cooling the refrigerant, connection to outside air is essential. If the cabinet is installed in front of a window, the window opening may be used for the air connection with a minimum of alteration work. If installed away from a window opening, provision for outside air connection will require either ducts from existing openings or else special openings must be made at the unit. Connection to circulating water is not required.

Older forms of heating cabinets need provision for getting water to the cabinet for humidification purposes and usually need separate piping to a drain in order to dispose of condensed water when dehumidifying. This cabinet permits extracting water from the outside air for humidifying purposes and disposal of condensed moisture to the outgoing air stream when dehumidifying. Thus, all piping connections to water are done away with. Fig. 7 illustrates the schematic layout and shows diagrammatically how the water for humidifying and from dehumidifying are handled.

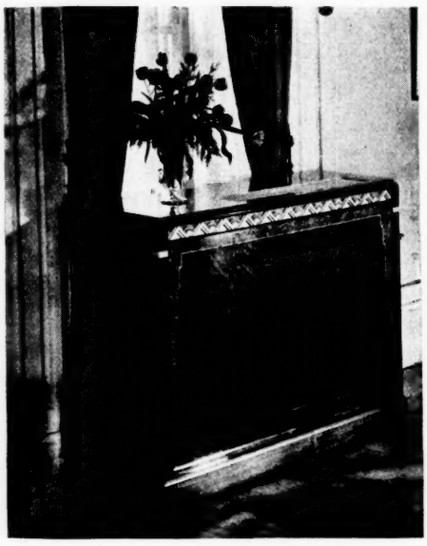


Fig. 8. Exterior of De La Vergne room cooler which employs reversed refrigeration cycles shown in Fig. 7.

Electrical supply must be from a 220-volt a.c. line and with a motor of 2 hp., the ordinary lighting circuit cannot be used. A suitable power circuit must therefore be at hand, or provided, having heavy enough wire for the imposed load.

It is stated that the cabinet will draw from 1½ kw. to 2½ kw., according to outside temperature. Without going into refinements of analysis, this indicates roughly an effect-power ratio of from 2.1 to 3.6. Operating results from the cabinet, not yet available, will be awaited with interest.

The Ever-Changing Picture of Automatic Heating for Residences

OIL and gas-fired equipment and automatically-controlled coal-burning apparatus have come into prominence during the past 12 or 13 years. They have found a considerable field in residential heating where their use has brought about such changes in practice that we have all felt their effects. The use of these methods of heating has been accompanied by progressive changes in both apparatus and fuel costs which have been continuously lowered.

In order that the nature of these changes may be seen readily and that a comprehensive picture may be at hand, the several charts presented here have been prepared. We believe that they show the situation so clearly that they are worth careful attention.

Fig. 1 shows the total number of residential heating plants as reported each year for the 12-year period beginning in 1921 and ending with the beginning of 1933. The line plotted at the top of the chart shows the total number of owned urban homes valued at $7500 (in 1930 dollars) or over each year as computed from census figures. While the figures, being collected from several sources, are not strictly correct the chart presents an interesting picture when interpreted.

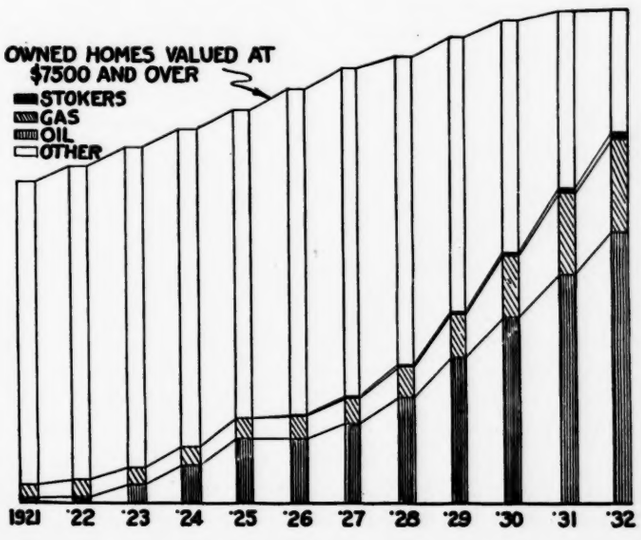
Plotting the upper curve across the chart is done *not* because all automatic plants have been put into owned urban homes valued above $7500, but this class of residence has certainly offered by far the greatest single market for these plants, and in the early years offered about the only one. Tenant-occupied houses or houses occupied by those in the lower income groups have not in general been a good market. While percentages cannot be read directly from the chart, it does show not only the progress of the newer fuel forms but it illustrates the extent to which these newer residential fuels have absorbed this market.

The white space at the top indicates the coal-burning plants, but the constant shrinkage does not show the loss of the total coal market. Owned urban homes in this value group are only a small portion of the total number of homes in the country. In the great bulk of these coal is still king.

Broadly, this chart shows that during the short period of 12 years the two fuels—oil and gas—have come from a condition where they were scarcely used at all to a place where approximately 1,000,000 installations are now operating in about 4% of the residences of the country. It is probable that about 4½ million people depend on them for their heat and that their annual consumption of fuel accounts for something more than 4% of that consumed annually.

While these facts are the broad ones there are others of interest. For instance, the number of gas-fired installations at 200,000 is about one-fourth as great as the number of oil-fired which now stands in the neighborhood of 800,000; while about 30,000 stokers are now installed in residences.

Although percentages cannot be read from the chart, still it gives an interesting figure to interpret the situation in terms of what the present status would be if these installations had all actually been made in owned



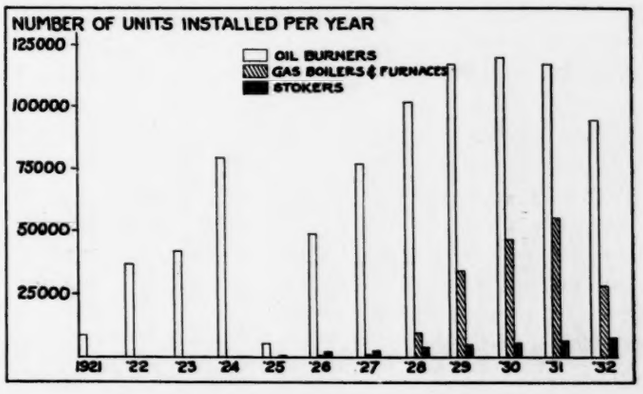


Fig. 1 (Left). The number of automatic heating jobs operating each year in the form of oil burners, gas-fired equipment, and stoker plants, showing how they are rapidly approaching saturation of the owned homes valued at over $7500. Fig. 2 (Below). The number of installations of three different fuel types made each year.

urban homes valued above $7500. If this were strictly true 74%, or three out of every four, of such existing homes would have a gas or oil-fired heating plant.

This in itself is of interest and well worth study. Evidently, the owned urban group valued above $7500 is not now nearly as attractive a potential field for oil and gas as it was 12 years ago. Much of what was then potential has now been converted into actual. With the relative exhaustion of this group as a source of potential it has been necessary to turn attention to other fields. The chart shows the necessity for this very clearly. This condition of affairs has already been well recognized and active steps have been taken because of it.

One has been the determined effort to reduce first costs in the case of oil-burning equipment, for each reduction tends to open up potential in residences of lower value. Much has been accomplished along this line as reference to Fig. 3 will show. In addition, oil-using equipment has been greatly helped in efforts to extend its appeal by the reductions in the price of the fuel itself. As a result, considerable headway has been made in popularizing oil in smaller and smaller buildings.

Gas has been helped by exactly the same factors which have helped oil to popularity. Reduced equipment and fuel costs and increasing acceptance of the conversion type of burner have helped to get it into wider use.

The divergence between the lines on Fig. 1 showing oil and gas installations is significant. It shows the relative rates of progress in number of installations. Note how much more of a space there is between them at 1932 than at 1928. Note, too, how much steeper the gas line is than the oil line during recent years. Fig. 2 brings this point out even more clearly. A glance at it shows that during the years 1930 and 1931 the number of gas-fired installations made was a sizable fraction of those equipped with oil. While the 800,000 installations of oil were made over a period of 12 to 13 years, the bulk of the 200,000 gas installations have been made during the past five or six years. During the past five years about 500,000 oil-fired installations have been made while approximately 150,000 gas-fired jobs have gone in. Thus, during this period gas has accounted for about one-third as many installations as has oil.

It is also interesting to compare the rate of progress of the two fuels for equal periods after they got going as residential heating fuels. During the first five years about 350,000 oil installations were made while during a corresponding period upwards of 150,000 gas-fired installations came into existence. Thus, during comparable periods of years, gas progressed about half as rapidly as oil.

The importance of the fuel prices and the changes in them has already been suggested. The chart of fuel prices (Fig. 3) is from those quoted in a large Pennsylvania city during each of the last 10 years. The quoted price of domestic anthracite fell only about 10% during the period while that of oil and of bituminous coal fell almost exactly one-third. Prices of gas fell slightly. At the end of the 10-year period oil was thus in a much improved position relative to anthracite.

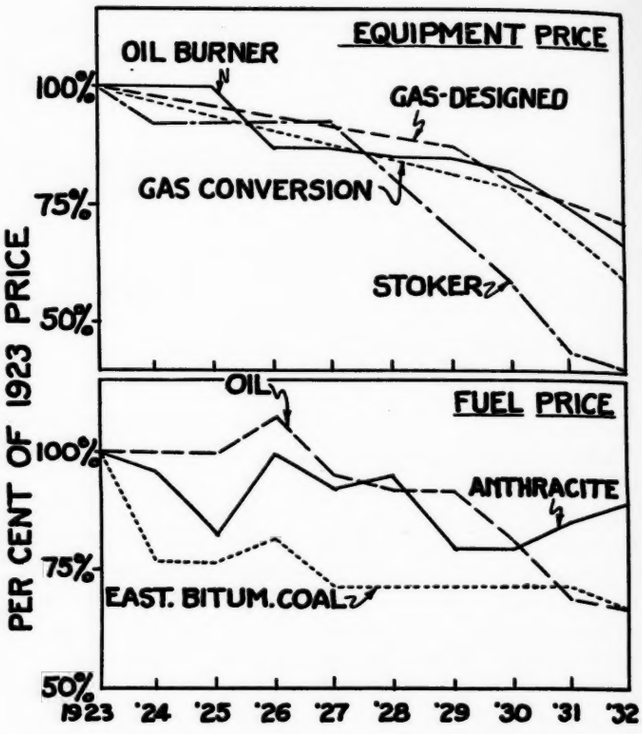


Fig. 3. The upper graph shows the trend in the first cost of equipment, the lower the trend in the fuel price for the different methods of automatic heating.

While the chart applies to conditions only in the city for which it is plotted, it also illustrates what has happened generally to the relative prices of oil and anthracite.

Equipment prices also underwent changes during this same period. Unit prices of a minimum installation of the several kinds required to handle the competing fuels in residence plants are also plotted in Fig. 3. They are based on reported costs from an eastern state and do not reflect all local conditions. They do show the general tendency. Note how closely the oil and gas-designed installations have paralleled each other in their percentage changes. This can be interpreted to mean that they now occupy approximately the same relative positions that they did in 1923. Costs of converted installations have fallen more sharply. Most sharp in decline have been the costs of stoker installations. The whole chart shows that from the standpoint of initial equipment cost the stoker-fired installation has improved its relative competitive position notably.

Thus, the picture before us is ever-changing, with the relationships between first cost of equipment and of the fuel fluctuating constantly. What the future holds no one can foresee. However, we may anticipate a strengthening of the oil burner competition due to the astonishing recent activity of boiler-burner unit manufacturers. The trend, apparently, is toward a boiler designed expressly for oil fuel. Contrasted with this we note that one of the large gas boiler manufacturers has entered the field with a gas conversion burner, reversing the trend taking place in the oil burner field. Activity of at least two large anthracite producers in developing new coal-burning equipment shows that that industry is fully alive to the need for improved solid-fuel-burning apparatus.

Air Conditioning—
Selecting the Cooling Equipment

By G. B. HELMRICH†

SELECTION of individual items of equipment which comprise a cooling system is equally as important as the choice of the cooling system itself. Before such equipment can be selected, however, a choice must be made of the type of cooling system which is deemed best suited for the particular project. This decision rests upon the determination of such factors as the magnitude and duration of the cooling load, the nature of the occupancy, the space available for equipment, and the possibility of integrating the cooling system with an existing heating or ventilating system. The total number of cooling hours to be expected during a cooling season has an important bearing on this choice as it is evident that a system involving a relatively low first cost, but high operating cost, may have the advantage when cooling is only required over short periods or at infrequent intervals. Conversely, commercial installations which are operated quite regularly throughout the summer can easily absorb a relatively high investment charge, but the operating cost must be low if the total annual cost is to be favorable. If the purchaser is to be assured that the cooling installation will produce results commensurate with the money expended, the premises should be surveyed by an engineer competent to evaluate these factors in their proper relationship.

Although air conditioning is generally understood to involve an independent control over the temperature, humidity, and movement of the air, recent experience with cooling installations has shown that it is entirely feasible to accomplish satisfactory comfort cooling by only controlling independently the dry bulb temperature. This is done with a thermostat so connected as to control the operation of the cold water pump. The cooling coil can be so arranged that the variations in the relative humidity of the air in the cooled space will not be such as to be noticeable to the occupants. Fig. 1 shows a simple arrangement of cooling equipment as it may be applied to a restaurant or store of moderate size.

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Refrigerating Machines

As the primary function of a comfort cooling installation is the removal of excess heat and moisture from the space to be cooled, a refrigerating machine or its equivalent is a necessary part of the system. The combined investment and operating cost of this unit of the cooling system forms the major part of the cost of cooling and the owner should give careful consideration to the choice of a machine that is suitable for the job. The principal equipment available for use as the primary cooling medium is the compression unit, the ice melting tank, and the steam ejector cooler. Although the public is most familiar with installations using the compression units, since they have been most widely used, the more recently developed ice melting tank and steam ejector cooler have distinct advantages for certain types of installations and should be given consideration.

COMPRESSION UNITS

In selecting a refrigerating machine for a particular cooling installation consideration should first be given to the method to be used in absorbing heat from the air. The air may be cooled by direct refrigeration, a method in which the evaporator coil is placed directly in the air circuit. This is frequently called cooling by direct expansion. The alternative is to place the evaporator coil in a tank of brine or cold water and circulate the chilled liquid, sometimes called the secondary fluid, through coils placed in the air stream, thus indirectly cooling the air. Since the use of direct expansion eliminates the intermediate step of refrigerating a secondary fluid, the cost of installation can be reduced by an amount equal to the cost of the tank, pump, and coils. There is an additional saving in both the first cost and operating cost of the refrigerating machine due to the fact that direct cooling permits the use of higher temperatures in the evaporator, with consequent higher suction pressures on the compressor, than is possible in the indirect method. As a consequence, the same cooling load can be handled by a smaller compressor than is possible with the indirect method, and the power consumption will be correspondingly less. In small in-

stallations the total cost may be reduced as much as 20% by the use of direct expansion.

Refrigerant. The choice of the refrigerant is important both from the standpoint of efficiency and safety. Some refrigerants, when mixed with the correct proportion of air, are explosive, while others are either poisonous or irritating to human beings. Some of the most efficient refrigerants, unfortunately, are open to this objection when used in cooling work. If the compressor is housed in a machinery room isolated from the rest of the building, the choice may be based on efficiency alone, and for the larger installations ammonia would be quite suitable, assuming, of course, indirect refrigeration. Carbon dioxide, being harmless in low concentrations and also non-explosive, is appropriate for installations where greater safety is required. The efficiency, however, is comparatively low, as the critical temperature is 88° and the working pressures range from 400 lb. to 1400 lb. per sq. in. The low critical temperature makes it unsuitable for use when cooling water for the condenser is warmer than 70°. In the smaller compression units, units of 10-ton capacity or less, methyl chloride and sulphur dioxide are frequently used, but the former is poisonous and the latter has a suffocating odor. Neither is well suited to direct expansion in the air stream of a commercial cooling installation.

A recently developed refrigerant known as freon, or F12, is non-toxic and non-combustible except under extreme temperatures. This refrigerant is now being used in direct expansion coils in room cooling units, and some cities are permitting its use for direct expansion in the main air stream of central cooling systems, provided the charge of refrigerant does not exceed 20 lb. A 20-lb. charge is adequate for a 10-ton machine, and if larger capacity is required the expansion coil may be sectionalized and fed by two machines. To summarize: the choice of a refrigerant for air cooling service involves an evaluation of its relative efficiency and safety. If it is desired to take advantage of the lower investment charge by using the direct method of refrigeration, safety should be the paramount consideration in all installations for buildings used by the general public.

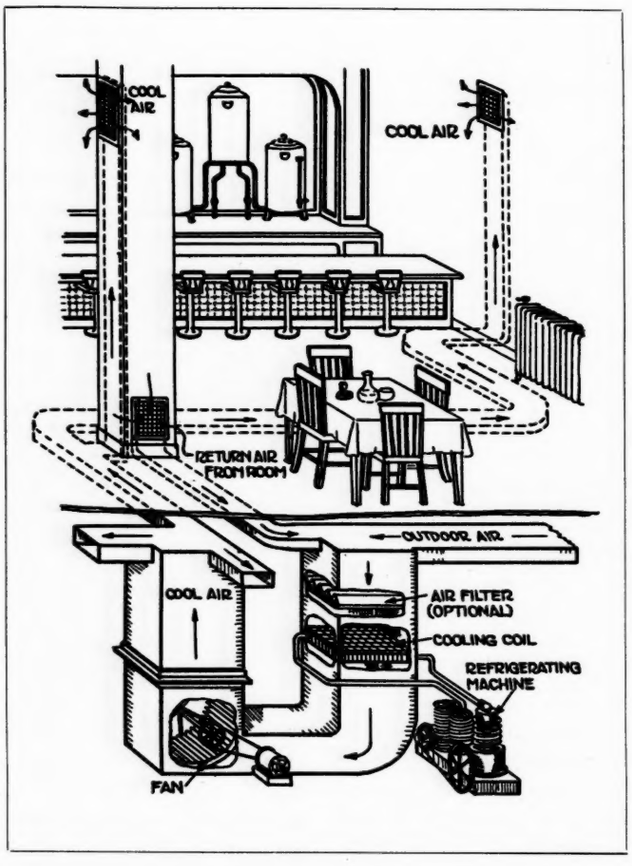


Fig. 1. Equipment for cooling a restaurant or store

Capacity. The size of refrigerating machine required for any job is dependent upon the calculated cooling load for the particular conditions involved. This cooling load can not be safely approximated by rule-of-thumb methods, but should be calculated on the basis of factors determined by a careful survey of the structure to be cooled. The rather complex nature of cooling load calculations makes it difficult to estimate the maximum load for any one hour, but it is possible to calculate the average maximum load over a 2 or 3-hr. period with reasonable accuracy. Whether machine capacity should be installed to take care of the maximum load will depend upon the nature of the occupancy. In commercial installations, such as stores and offices, the average load usually does not exceed 45% to 55% of the maximum demand, and in cases where the occupancy is continuous and the maximum load of short duration, a saving in installation cost may be made by installing a machine with a tonnage rating equal to about 80% of the calculated maximum load. In installations such as restaurants, however, where it is essential to maintain conditions of maximum comfort during periods of highest occupancy, the machine should be of ample size to handle the peak cooling load. As an example: a restaurant with a capacity of 200 people might have a maximum cooling load of 225,000 B.t.u. per hr., equivalent to 18.7 tons. A 20-ton machine should be installed for this job. If it is desired to cool by direct expansion, two 10-ton compressors could be installed, which would permit holding the charge of refrigerant in each machine to the code limit of 20 lb. for a class "D" commercial system.

The power consumption per ton of refrigeration will vary with the refrigerant, the temperature of the condensing water, and the temperature of the evaporator. For machines up to about 5-ton capacity the power requirement will approximate 1 kw. per ton of refrigeration, while for larger machines, such as 10-ton capacity, the requirement will be about 0.9 kw. per ton. Allowing for the motor efficiency, the size of motor required will be about 1 hp. for each ton of refrigerating capacity. The squirrel-cage induction motor with V-belt drive is well suited for driving compressors of 2 hp. to 50 hp. For automatic machines under 2 hp. or 3 hp., the repulsion-induction or the capacitor motor is well adapted, and the latter combines low-starting current with high-starting torque and is exceptionally quiet in operation as well as being non-radio interfering.

Sound Isolation. Since in most small commercial installations the compressor is placed rather close to the

space to be cooled, it is quite important that precautions be taken to insulate the equipment against the transmission of vibrations causing objectionable noise. Sponge rubber placed between bearing surfaces is very helpful for this purpose, and a cork block placed under the entire machine base is a good sound insulator. The holding-down bolts should also be insulated with rubber washers and bushings.

Condenser Water. The quantity of condenser water required for any given machine has an important bearing on the cost of operation. The colder the water, the more efficient the refrigerating cycle becomes. When water is quite costly, the double-pipe condenser may be used instead of the better known shell and tube type, as its construction permits of the same heat dissipation with the use of less water. The cooling water temperature has a considerable effect on the cooling capacity of the compressor. As an example: a methyl chloride compressor which has a certain capacity when using condenser water at 76°, will have a capacity 3½% less for 86° water, and 6% more for 60° water. The quantity of condensing water required per ton of refrigeration will vary from about 1 to 3 g.p.m., depending upon the refrigerant, the water temperature, and the type of condenser used.

STEAM EJECTOR COOLER

A new type of refrigerating machine has been developed within the last two years which operates on the absorption principle and refrigerates by flash evaporation under vacuum. It is known as the steam ejector cooler and represents a new application of the old and well-established principle that water will vaporize at low temperatures under high vacuum, and the latent heat required for the vaporization will be absorbed from the remaining water in the evaporator. This results in a chilling of the water to a temperature corresponding to the boiling temperature for the particular vacuum carried in the evaporator. Although the application of this principle to refrigeration for air cooling purposes is a new development, the equipment used is of standard design and has been used for other purposes for many years. It consists of an evaporator, a steam ejector, a condenser, a secondary ejector, and a cold water pump. Water being the refrigerant, what amounts to direct expansion cooling can be employed without the precautions necessitated in the use of other refrigerants. Within the narrow range of temperatures required for air cooling with cold water this device is decidedly efficient as compared with the compressor type of unit. As it uses steam as the compressing medium, the steam being expanded through a simple ejector or thermo-compressor, the unit is particularly applicable when district steam service is available.

The steam consumption of the unit will vary from 35 lb. to 50 lb. per hr. per ton of refrigeration when supplied with steam at 30-lb. gauge pressure, the pressure usually available in district steam distribution systems. When condensing water is particularly expensive, the steam ejector cooler is at a disadvantage as it requires from 4 to 7 g.p.m. of cooling water per ton of refrigeration. Under unfavorable conditions the cost of condenser water may equal the cost of steam. The space requirements for a complete unit are considerably less than for the compressor type. A 14-ton unit will occupy a space 12 ft. × 2½ ft. × 9 ft. high. A thermostat controls the evaporator water temperature by opening or closing the steam supply valve, and this results in an intermittent operation of the unit. As there are no moving parts in the major equipment, the maintenance costs are extremely low, and this lack of moving parts makes possible an operating unit of unusual quietness.

COOLING WITH ICE

The ice melting tank has only been extensively applied to air conditioning during the past two or three years. It is not generally realized that ice represents stored-up refrigeration in a form and at a temperature that is very useful for comfort cooling. It possesses the merit of flexibility in the rate of refrigeration through the simple expedient of varying the ice melting rate by changing the quantity of water circulated through the tank. The ice melting tank is simple in construction and consists essentially of an insulated tank made of concrete, steel, or wood. Its size should be sufficient to provide the volume required to hold a day's supply of ice together with enough water to partially submerge the ice. A distributing pipe for the return water from the coils, a cold water outlet at the bottom of the tank, an overflow connection, and a door for charging the tank with ice, constitute the necessary fittings. Fig. 2 shows an ice melting tank for a commercial cooling installation of 3½-ton storage capacity.

Size and Capacity of Tank. In commercial installations it is desirable to have a tank large enough to hold a day's supply of ice and the quantity of ice required will be a function of the calculated cooling load. For example: a theater having a maximum cooling load calculated to be 225,000 B.t.u. per hr. will probably have an average load for the most severe day of approximately 180,000 B.t.u. This is arrived at by assuming one-third of the maximum load to be made up of such constant heat sources as lighting, while the balance is assumed to be 70% effective throughout the day. It should be borne in mind that the calculated cooling load should include an allowance for the unauthorized losses in the piping and water tank. These losses may amount to as much as 20% in a 5-ton installation and 5% to 10% in a larger one.

Pounds of ice melted per hour for maximum day $= \frac{180{,}000}{144 + (55\text{-}32)} = 1080$, in which 144 is the heat of fusion of ice and 55° is the temperature at which the water leaves the cooling coils and is wasted to the drain.

Total ice melted for a maximum day = 1080 lb. per hr. × 6 hr. = 6480 lb. Allowing 10% for unauthorized losses, the ice required for a maximum day's run will be 6480 ÷ 0.90 = 7200 lb. = 3.6 tons.

Volume of the ice $= \frac{7200}{56} = 128$ cu. ft.

Space required in ice tank, allowing 40% for voids, $= \frac{128}{0.60} = 214$ cu. ft.

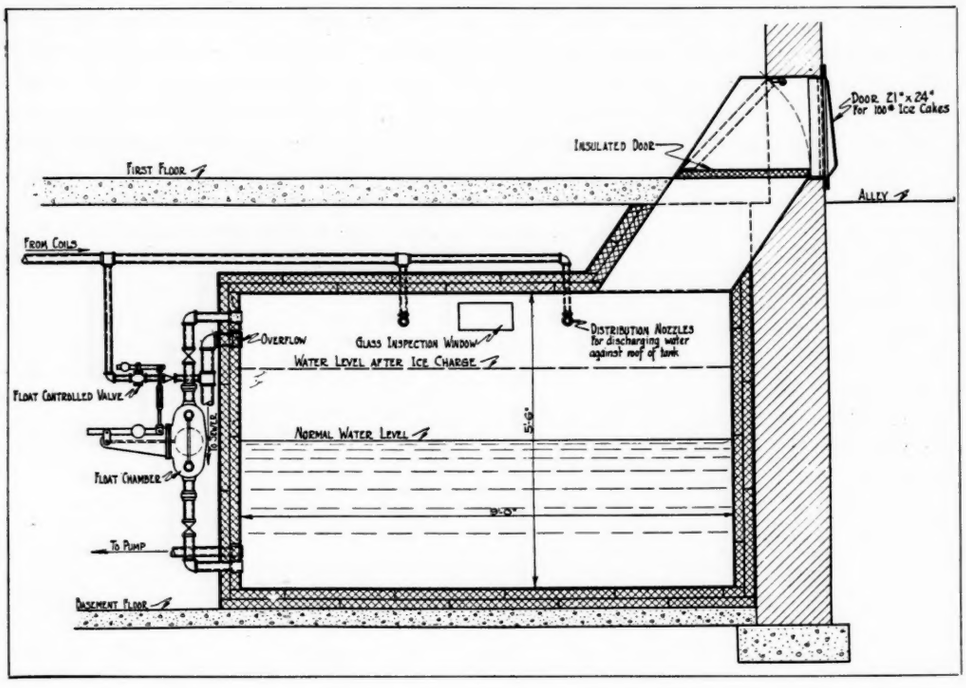


Fig. 2. Ice melting tank having a capacity of 3½ tons

few hours. Wood tanks will usually not require insulation. Where it is desirable to store ice for a longer period than one day's run, the insulation should be 4 in. of corkboard, or its equivalent. Wool felt or hair felt is suitable for the 2-in. insulation. All ice water lines should likewise be insulated with this material. The tank should be provided with an overflow connection, and to avoid wasting cold water to the overflow, a branch line from the warm water return from the cooling coils can be run to a float chamber. Whenever the water level tends to rise, the float valve will waste the discharge water from the coils to the sewer, and thus avoid wasting cold water to the overflow.

The area of the tank will be a function of the depth of water and ice which seems most desirable. Experience has shown that a depth of water of about 24 in. to 30 in. is sufficient to protect the bottom of the tank against the impact of falling ice and to float the ice away from the charging chute so it will not pile up when delivered to the tank.

Depth required for water and ice = 4 ft.

$$\text{Area of tank} = \frac{214}{4} = 53 \text{ sq. ft.}$$

Total depth of tank = 4 ft. plus an allowance of 1½ ft. for internal piping = 5½ ft.

The approximate tank dimensions will be 6 ft. × 9 ft. × 5½ ft. For the average installation, a ratio of 4½ cu. ft. of tank volume for each 100 lb. of ice to be melted will give satisfactory results.

Method of Ice Melting. Comparative tests have been made in which, in one instance, water was sprayed over ice supported on a rack, while in the other the ice was simply floated or submerged in the water. Although the spraying of the ice resulted in lower water temperatures and higher rates of heat transfer at the start, the results were not maintained, due to the spray melting holes in the ice. The submerged method gave uniform results and is much more simple to apply. Sprays require higher pump pressures, interfere with ice charging, and are apt to clog up. There seems to be no economic justification for increasing investment costs by the use of sprays, but there is an advantage in the use of a perforated distribution pipe which will splash the water against the top of the tank and allow it to rain down over the ice cakes. This prevents the short circuiting of the warm return water to the tank outlet.

Tank Construction. Tanks should be of very substantial construction and can be made of steel, cypress, or concrete. The steel should be 3/16 in. to ¼ in. thick, and the cypress not less than 2 in. thick. For the smaller sizes, 2 in. of insulation should be sufficient, especially in cases where the ice charge is used up in a

The location of the tank has an important bearing on the cost of ice as it affects the cost of delivery. The tank can be located under the sidewalk with an ice-charging door near the curb, or just inside a basement wall with a charging door accessible from a driveway. In any event it should be possible to charge the ice tank directly from the ice truck. The charging door should be large enough to take 100-lb. cakes of ice.

Control of Water Temperature. The melting of ice in a tank in an air conditioning installation is subject to the following laws: The ice melting rate, for a given entering water temperature, is directly proportional to the quantity of water circulated. With a given entering water temperature, the water will leave the tank at a substantially constant final temperature, regardless of the rate of water circulation. The cooling effect of the coils can be regulated by a room thermostat connected to stop and start the ice water pump, or the flow of water can be regulated by hand. Another method is to control the operation of a mixing valve by a thermostat in a manner which will control the temperature of the water entering the coils. This is accomplished by by-passing some of the warm water around the tank.

Cold Water Pumps

The cold water pump is a necessary piece of auxiliary equipment in most cooling installations. In selecting a pump for this kind of service it is most important that consideration be given to the reliability of the unit and its freedom from objectionable noise and vibration. The efficiency of the unit will usually be satisfactory if the pump is purchased for the capacity and head actually required by the installation. Direct-connected motor-driven centrifugal pumps meet the above requirements most satisfactorily.

Capacity. The capacity required is a function of the

cooling load and the rise of water temperature in the cooling coils that is most economical. In air cooling service the water usually enters the cooling coils at from 40° to 48° and leaves at from 50° to 55°. The average temperature rise may be assumed to be 8°, and on this basis each ton of refrigeration produced will require a flow of cooling water of 3 g.p.m. When an ice melting tank is used as the refrigerating unit a ratio of 1 g.p.m. of pump capacity for each 25 lb. of ice melted per hour has given satisfactory results. The working head on the pump will, of course, depend upon the relative position of the water tank and the cooling coils and upon the friction loss of the coils and piping. In installations where the equipment is all placed between the same two floor elevations the head will vary from 20 ft. to 35 ft. The power required for pumping is likewise a variable and will range from ½ hp. for a 10-g.p.m. pump to 3 hp. for a 50-g.p.m. capacity.

Sound Isolation. The pumping unit is very apt to produce operating noises which will be transmitted into the space being cooled if care is not taken to guard against it. This is especially true if the unit is only separated from the conditioned area by one floor or a partition wall. Pump noises can be greatly reduced by insulating the unit from its foundation by placing it on rubber discs, soft rubber strips, or a cork pad. The pump suction and discharge connections should be joined to the piping by flexible rubber hose of sufficient length to form the equivalent of a U-bend. Short lengths of 5 in. or 6 in. will not answer the purpose. Motor noise can be reduced by selecting a motor with a well-balanced rotor, and for sizes up to about 3 hp., the capacitor motor is available and is very satisfactory from the standpoint of quietness in operation.

Cooling Coils

Cooling air by the surface cooling method involves the same principles of heat transfer as have been employed for many years in blast heating, but some of the factors affecting the heat transferred per square foot of surface have decidedly different values from those used in heating. Instead of circulating steam or hot water through the coils and transmitting heat to the air, cold water is pumped through the coils and heat is absorbed from the air. In cooling work this heat is absorbed at a much lower thermal head, or temperature difference, than in heating and, consequently, the total heat transferred per square foot of surface will be greatly reduced. There is also the complicating factor of the latent heat of dehumidification to be considered.

The cooling surface or cooling coil is usually an extended surface of the fin-tube type, but the manner in which the fins are joined to the tubes, the tube spacing, and length of the fins, are all matters of individual design by each manufacturer. This has resulted in a wide variety of cooling coils with surfaces greatly differing in effectiveness, and the mere fact that a cooling coil has a certain number of square feet of cooling surface does not give assurance that it has the proper cooling capacity. Heat transfer surface designed for heating work is usually very poorly adapted to cooling as the fins, or secondary surface, extend too far away from the tubes, or primary surface. The relatively small temperature difference between the water and the air make the outer portion of such surfaces ineffective.

Materials usually employed in coil construction are copper, brass, and aluminum. In localities where the air is apt to have a highly corrosive action on the wetted coil surfaces, aluminum is particularly suitable. Provision should be made for draining the condensate from the coil surfaces and away from the main air stream so that the air will not pick up moisture again.

Heat Transfer Capacity. The heat transfer capacity of an extended surface cooling coil is a function of the total heat transfer surface, both primary and secondary, the velocity of the air over the surface and of the water through the tubes, the ratio of latent heat to sensible heat load, the mean temperature difference between the air and the cooling water, and the design of the surface. The sensible heat transmitted per square foot of surface, per degree of mean temperature difference, per hour, usually termed K, is a function of the above factors and can usually be obtained from the manufacturer. The required extent of cooling surface can then be determined by dividing the calculated sensible heat load in B.t.u. per hour by the product of K and the mean temperature difference between water and air. In cases where the value of the heat transfer coefficient is not readily obtainable it may be assumed, for estimating purposes, to be 10, and the mean temperature difference may be assumed as 15°. This results in a sensible heat transfer capacity of 150 B.t.u. per sq. ft. of surface per hour. It should be noted that although only the sensible heat load is considered in calculating cooling surface, the total of sensible and latent heat should be considered in computing the cooling water requirements.

The responsibility for supplying the correct amount of cooling surface may be placed upon the manufacturer, and in that case the following data should be furnished him:

Maximum cooling load—B.t.u. per hour.
Percentage of cooling load due to dehumidification.
(Assume 10% to 20%; the higher figure should be used when occupancy and ventilation requirements are above ordinary office requirements).
Capacity of fan—cubic feet per minute.
Mean temperature difference between air and water—Assume 15° to 20°.
Mean temperature of water in coils—Assume 50°.
Quantity of water circulated through the coils—gallons per minute.

Arrangement of Coil. It is important that the frontal or face area of the coil be sufficient to limit the velocity of the air to values which will not involve such high

friction losses through the coil as to require excessive fan power. On the other hand, it is advantageous to have depth to the coil with a counter-current arrangement. As high air velocities improve the rate of heat transfer, it can be seen that the choice of the ratio between the area and depth of the coil involves a compromise between these factors. In general, where duct area permits, the velocity of the air should not exceed 400 to 500 f.p.m., based upon the frontal area of the coil. The corresponding friction loss will vary from 1/10 in. water to as high as ½ in.

The coil should be so arranged that the water will pass across the air stream at least twice and preferably three or four times. The flow of water through the coils should be counter-current to the flow of air. To accomplish this it is sometimes necessary to sectionalize the coils. The counter-flow of water and air brings the colder air in contact with the coldest water and, if the initial temperature of the water is kept constant, the air will be properly dehumidified even though the flow of water is varied. With a proper relationship between face velocity of air through the coils, counterflow of water, and spacing between primary and extended fin surfaces, the relative humidity of the air can be controlled throughout the range of cooling load. All of the air may be passed through the cooling coil without the need of reheating to avoid objectional drafts, as coils installed in this manner will properly dehumidify and still permit the air to leave at temperatures 5° to 8° above the dew point, equivalent to temperatures of 60° to 65°.

Air Filters

Although, strictly speaking, air conditioning does not necessarily include the filtering or cleaning of the air, it nevertheless is a very desirable thing to do, especially in installations located in the business or industrial areas of cities. A satisfactory air filter should be efficient in dirt removal, should have low resistance to air flow and large dust-holding capacity, and should be easy and economical to clean or to renew.

Types of Filters. Filters fall into three general classifications: the dry filter, in which air is drawn through cloth, cellulose-like paper, or wool-like substances such as finely-spun glass; viscous filters, in which the air is cleaned by the impingement of its dust particles on viscous surfaces; the air washer, in which the dust is collected on water-wet surfaces and washed off into a collecting tank. The air washer is usually installed primarily for cooling, humidifying, or dehumidifying the air, with air cleaning a secondary consideration. The air washer does not filter very efficiently and should not be used as a substitute for a filter. The viscous filters employing travelling screens which pass through a bath of oil have long been used in large installations, but in the medium and small capacities the dry filter or stationary viscous filter is finding increasing favor.

Capacity and Efficiency of Filters. The capacity of a filter for any fixed resistance is a function of the area of the filter and the nature of the filter medium. Its efficiency of dirt removal is a function of the kind of filter material and the linear velocity of the air through the filter. For most filters this velocity should not exceed 400 f.p.m. if high efficiency is desired. Velocities of 300 to 400 f.p.m. through the filter will usually give efficient dust removal with economy of space requirements. The linear velocity of the air through the filter is understood to be the velocity which the air would have when flowing through a duct of the same cross-sectional area as the frontal or face area of the filter. Before choosing a filter that is best suited for a particular installation, the quantity of air to be filtered, the permissible resistance of the filter, and the space available for installation, should be determined. If the filtering medium itself is placed at a right angle to the flow of air, the area of the medium is, of course, equal to the face area of the filter, but in commercial installations it is frequently impossible to provide enough duct area on this basis to keep the filter resistance down to a reasonable figure. To meet this condition many filters are designed so that the filter medium has an area several times greater than the face area of the filter. This increase of the effective area of the filter medium is accomplished by the use of filter pockets, which makes possible the passing of more air through the same face area of filter without increasing the resistance to air flow. Tests have shown, however, that beyond a certain ratio of actual filter medium area to filter face area, the capacity actually falls off for a fixed resistance of filter unit. Because of these considerations the choice of filter area must be based upon a compromise between the space to be occupied by the filter and the air resistance that the fan can economically work against.

The application of these principles to the choice of a filter can best be illustrated by a typical example. It is assumed that a restaurant requiring 10 tons of refrigeration will require about 5000 c.f.m. of air for cooling and ventilating, and that the filtering will be accomplished with dry or stationary viscous filters. The efficiency of dust removal of the filter is assumed to be not less than 95% when clean. Air velocities through the filter are not to exceed 400 f.p.m. If the fan has a capacity of 5000 c.f.m. against a static pressure of 0.75 in. water gauge, the allowable resistance of the filter when clean can be found by deducting from 0.75 the combined resistance of the cooling coil and duct work and the increase in resistance from a clean to a dirty filter.

If we assume a combined duct and coil loss of 0.45 in. w.g., and a type of filter that will increase in resistance about 0.16 in. w.g. from a clean to a dirty state, we have a total static loss of 0.61 in. Deducting 0.61 from 0.75 leaves 0.14 in. for the permissible resistance of the filter when clean. In installations requiring new fans the resistance of the filter would first be estimated and the fan power calculated to take care of it. For this type of installation an assumption of 0.14 in. to 0.25 in. w.g. for the resistance of the clean filter will usually give satisfactory results. For this filter resistance the linear velocity through the filter may be assumed to be about 400 f.p.m. and to filter 5000 c.f.m. will require a face area of about 12 sq. ft. As many manufacturers have standardized on filter units which measure 20 in. × 20 in. normal face area, it is convenient to base capacity on this unit of area. Such a unit, depending,

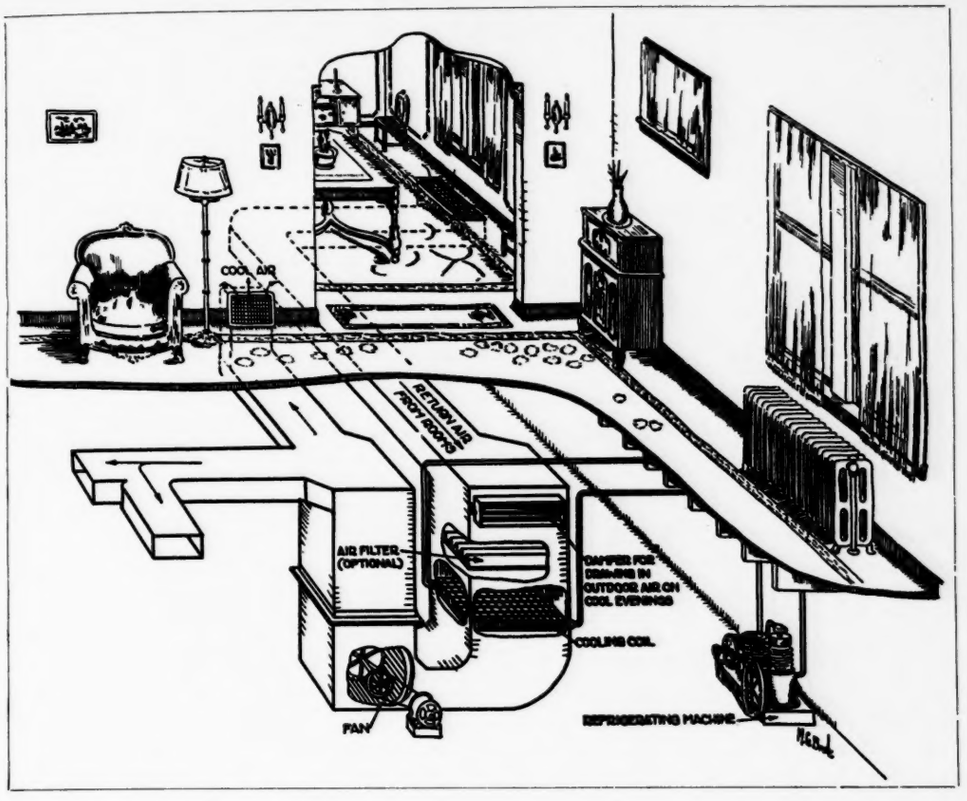


Fig. 3. Cooling system for a home heated with steam

of course, upon its design, will have a capacity of 600 to about 1100 c.f.m. with resistances varying from 0.08 in. for 600 c.f.m. to as high as 0.25 in. w.g. for 1100 c.f.m. If we assume a capacity of 1000 c.f.m. per unit at a resistance of 0.16 in., a capacity of 5000 c.f.m. will require five such units with a combined area of 13.9 sq. ft., but a symmetrical arrangement will call for six units. It is advisable to limit the capacity required of each unit to a maximum of 1100 c.f.m., as beyond this limit the efficiency of dust removal usually falls off rapidly. If manufacturers' data are available, the selection of the proper face area of the filter can be made on the basis of curves showing the resistances of specific filter units with corresponding capacities and space requirements.

Fans

A discussion of all of the considerations involved in the selection of a fan for a cooling installation would be so involved as to be quite outside the scope of this article. Recent experience with cooling installations has shown, however, that there are a few factors to be considered that are of particular importance if satisfactory cooling is to be accomplished, and this discussion will be confined to these subjects.

Capacity Required. The quantity of cool air to be circulated to carry any definite cooling load is dependent upon the temperature at which it is introduced into the space to be cooled. The lower the temperature of introduction, the smaller the quantity of air required. Experience has shown, however, that air temperatures at the inlet grilles of from 60° to 65° are as low as should be used if objectionable draft is to be avoided. These temperatures permit carrying the cooling load with room temperatures of from 75° to 80°, corresponding to a temperature rise of 15° to 18°. This temperature rise measures the sensible heat absorbing capacity of the air. Under these conditions the cooling load can usually be carried by circulating a quantity of cool air which is equivalent to from 10 to 15 air changes per hour in commercial installations, and 6 to 8 per hour in residences. The ventilating requirements and internal sources of cooling load in such buildings as restaurants will involve air quantities approaching the higher figure. The upper limit of temperature of the cooling air is established by the maximum quantity of air that can be circulated without having to use duct and grille velocities so high as to result in objectionable noise, draft, and high power consumption. The choice of fan capacity best suited for a specific installation must, of necessity, involve a compromise between these limiting factors.

To illustrate, we may use as an example the restaurant previously referred to in the discussion of air filters. If we assume a maximum cooling load of 10 tons, of which 80% is sensible heat load, the temperature rise of the cool air introduced into the conditioned area must be such as to permit a heat absorption of 96,000 B.t.u. per hr. By trial and error we find that a temperature rise of 18° for the cooled air will require the circulation of 5000 c.f.m. to cool a space with an estimated volume of 20,000 cu. ft. The resultant rate of air change is 15 per hour. The equations as finally balanced are as follows:

5000 c.f.m. × 0.075 lb. per cu. ft. × 60 × 0.24 (spec. heat) × temp. rise = 96,000.

Temperature rise = 18°; air to be introduced at 60° and allowed to rise to a room temperature of 60° + 18° = 78°. Rate of air change $= \frac{5000 \times 60}{20{,}000} = 15$ air changes per hour. It must be determined, of course, whether duct and grille velocities are reasonable at this rate of air change.

Type and Arrangement. Centrifugal fans of the multi-blade type are the best suited and most commonly used for ventilating and cooling work. Although such fans may be directly connected to the driving motor, a much more flexible arrangement is made possible by the use of a V-belt or rope drive. Fan speeds can be conveniently adjusted to changed conditions by simply changing pulleys, and motors of standard speeds can be used to drive the fan at whatever lower speed is best suited to the service.

RESIDENCE COOLING (WITH ICE OR A REFRIGERATING MACHINE)

Recommended Equipment Sizes as Applied to a Warm-Air Furnace or Steam-Heating Installation

Type of Construction—Ordinary Brick Veneer or Frame—No Insulation

	Rooms to be Cooled	Volume, Cu. Ft.	Capacity of Fan—C.F.M. at ⅜" S.P.	Cooling Coil Surface Sq. Ft. Assumed 150 B.t.u. per sq. ft. per hr.*	Capacity of Cold Water Pump, G.P.M.	Capacity of Ice Melting Tank Vol., Cu. Ft.	Capacity of Ice Melting Tank Nominal Capacity Lb. of Ice	Capacity of Refrigerating Machine, Tons
COOLING RESTRICTED TO CERTAIN ROOMS	Living	2000	420	120	2½	30	500	1 to 1½
	Dining	1600						
		3600						
	Living	3000	530	150	3	34	600	1 to 2
	Dining	1600						
		4600						
	Living	3800	900	175	4	42	800	2 to 2½
	Dining	2000						
	Kitchen	1600						
		7400						
	Living	3800	1200	210	6	53	950	2 to 3
	Dining	2000						
	Kitchen	1600						
	Bed Room	2000						
		9400						
COOLING ENTIRE RESIDENCE	No. of Rooms in House							
	6	12000 to 15000	1600	240	7	42	800	2 to 3½
	8	15000 to 20000	2000	280	8	66	1200	2½ to 4½
	10	20000 to 25000	2600	350	10	80	1500	3 to 5

**For cooling surface heat transfer rates other than 150 B.t.u. per sq. ft. per hr., choose the surface in proportion.*

In cooling installations it is frequently of the utmost importance that fan noises be carefully isolated so that they will not be communicated to the area being cooled. Noise from an operating fan is chiefly a function of fan speed, air discharge velocity, and velocity through ducts and grilles. For standard multi-blade ventilating fans 600 r.p.m. should not be exceeded, and 400 to 500 r.p.m. is the preferable range for quiet operation. For the same reason the discharge velocity should be limited to about 1200 f.p.m. The fan wheel should be well balanced and the fan assembly should be set on a sound-isolating base of such materials as soft rubber or cork. The connections between the fan and the ductwork should be of canvas to prevent the spreading of fan vibrations. For driving the smaller sizes of fans the recently developed capacitor motor is very satisfactory and is quiet in operation. For larger sizes the manufacturers are prepared to furnish induction motors with particularly well balanced rotors to insure freedom from electrical and mechanical noises. If the fan speeds and air velocities are kept within the limits recommended by the manufacturer, and the other recommendations concerning sound isolation are carefully followed, it should be possible to eliminate all operating noises of an objectionable nature.

Residence Cooling

Cooling equipment for residences is essentially the same as that for commercial installations. The fan need only have a capacity equivalent to 6 or 8 air changes per hour, as daytime ventilation by the use of outdoor air is not required. There is an economic advantage, however, in making a provision for bringing in the cooler night air so that its cooling power may be utilized. Since a residential cooling load is due very largely to external sources of heat, it is possible to estimate, with reasonable accuracy, the cooling load for certain types of residences if the general latitude of the locality is known. The writer is submitting a tabulation of such estimates with the thought that it may prove useful in determining sizes of cooling equipment, but with a full realization that the recommendations contained therein may need modification as the art develops and more data become available. Fig. 3 shows the general arrangement of cooling equipment as it may be applied to a residence heated by direct radiation.

The table of recommended sizes of cooling equipment is applicable only to residences, and it assumes a normal condition of occupancy and use. If awnings are used, the equipment sizes, with the exception of the fan, can be reduced about 20%. The fan capacities assume a rate of air change approximating 7 per hour. The ice melting tank will vary in size from 27 in. × 36 in. × 48 in. for 500 lb. capacity to 27 in. × 54 in. × 67 in. for 1200 lb. capacity. The horsepower of the driving motors for fans and pumps will vary from ¼ to a maximum of ¾. The ice melting tank and cold water lines should be insulated with about 2 in. of hair felt, wool felt, cork, or the like.

OUTSIDE TEMPERATURES USED FOR DESIGN IN HEATING CALCULATION IN 96 CITIES

(Lowest recorded temperatures from publications of the U.S. Department of Agriculture, Weather Bureau, covering long periods from 20 to 50 years up to about 1922. Design temperatures those used by readers of HEATING AND VENTILATING*)*

State	City	Lowest Recorded Temp., °F.	Design Temp. Actually Used, °F.
ALABAMA	Birmingham	−10	10
	Mobile	−1	20
	Montgomery	−5	15
ARKANSAS	Fort Smith	−15	−15
	Little Rock	−12	0
CALIFORNIA	Los Angeles	28	30
	Sacramento	19	30
	San Francisco	29	30
CONNECTICUT	New Haven	−14	−5
DIS. OF COLUMBIA	Washington	−15	0
FLORIDA	Jacksonville	10	27
	Pensacola	7	20
GEORGIA	Atlanta	−8	10
	Macon	−4	10
	Savannah	8	20
ILLINOIS	Champaign	−25	−10
	Chicago	−23	−10
	Rockford	−26	−10
INDIANA	Fort Wayne	−24	−10
	Indianapolis	−25	−5
	Terre Haute	−18	−10
IOWA	Davenport	−27	−10
	Des Moines	−30	−15
	Sioux City	−35	−18
KANSAS	Wichita	−25	−5
	Topeka	−22	−5
KENTUCKY	Louisville	−20	−5
LOUISIANA	Baton Rouge	2	20
	New Orleans	7	25
MARYLAND	Baltimore	−7	0
MASSACHUSETTS	Amherst	−22	0
	Boston	−14	0
	Fitchburg	−17	0
	Nantucket	−6	0
MICHIGAN	Detroit	−24	0
	Saginaw	−23	0
	St. Joseph	−21	−10
MINNESOTA	Minneapolis	−33	−15
	Rochester	−42	−20
MISSOURI	Kansas City	−22	−10
	St. Louis	−22	−5
NEBRASKA	Omaha	−32	−20
NEW HAMPSHIRE	Concord	−35	−10
NEW JERSEY	Atlantic City	−7	0
	Dover	−21	0
	Jersey City	−12	0
	Newark	−13	0
	Patterson	−13	0
	Trenton	−13	0
NEW MEXICO	Albuquerque	−10	0

(Continued on other side)

OUTSIDE TEMPERATURES USED FOR DESIGN IN HEATING CALCULATION IN 96 CITIES

(Concluded from other side)

(Lowest recorded temperatures from publications of the U.S. Department of Agriculture, Weather Bureau, covering long periods from 20 to 50 years up to about 1922. Design temperatures those used by readers of HEATING AND VENTILATING*)*

State	City	Lowest Recorded Temp., °F.	Design Temp. Actually Used, °F.
NEW YORK	Albany	−24	−10
	Binghamton	−28	−5
	Buffalo	−14	0
	Elmira	−24	−10
	New York	−13	0
	Syracuse	−22	−2
NORTH CAROLINA	Greensboro	−3	20
NORTH DAKOTA	Bismarck	−45	−30
	Fargo	−48	−30
OHIO	Cincinnati	−17	−5
	Cleveland	−18	0
	Dayton	−16	0
OKLAHOMA	Oklahoma City	−17	5
OREGON	Portland	−2	5
PENNSYLVANIA	Erie	−16	5
	Harrisburg	−14	0
	Lancaster	−27	0
	Philadelphia	−6	5
	Pittsburgh	−20	0
	Scranton	−15	−5
	Uniontown	−22	0
	York	−17	0
RHODE ISLAND	Providence	−12	0
SOUTH CAROLINA	Charleston	7	20
	Columbia	−2	10
SOUTH DAKOTA	Aberdeen	−46	−20
TENNESSEE	Chattanooga	−10	0
	Nashville	−13	0
TEXAS	Dallas	−10	10
	Fort Worth	−24	14
	Houston	6	20
	San Antonio	4	20
UTAH	Salt Lake City	−20	0
VERMONT	Burlington	−28	−10
VIRGINIA	Lynchburg	−7	0
	Richmond	−3	10
WASHINGTON	Seattle	3	10
	Spokane	−30	−10
	Tacoma	7	10
	Walla Walla	−17	−10
WEST VIRGINIA	Wheeling	−25	0
WISCONSIN	Madison	−29	−15
	Milwaukee	−25	−17
	Sheboygan	−38	−10
WYOMING	Laramie	−42	−10
	Sheriden	−45	−30

Just Where Does the Small-Building Cooling Situation Stand?

Results of a survey made to determine the number of air conditioning systems operating in this country and the type of building in which they are installed

BUILDING cooling is so new that there has been almost no reliable information as to how many installations have been made. We have all heard, and all know well, that it is in its infancy; that it is just getting started, and that the number of cooled buildings does not constitute any appreciable percentage of those now in existence. This lack of information results in a rather unsatisfactory state of affairs.

In order to get together some information as to the existing situation, we asked selected readers of HEATING AND VENTILATING in cities of 75,000 or over to cooperate by reporting the number of such jobs which they knew to be in existence. It was felt that this method would result in reliable returns because men were selected who were familiar with local conditions and who were in a position to know of all such jobs. In the larger cities this method offered the difficulty that no one person would be likely to know of all installations. This was especially true of New York and its surrounding suburbs. In these cities information was requested from several sources and was cross-checked where possible to be sure that the same installations were not being reported more than once. In a number of cases electric utilities were consulted as they sometimes keep records of the nature of apparatus connected. Since ice cooling has made some progress it seemed well to try to separate the ice-cooled jobs from the others, and separate requests were sent to the ice companies in a number of cities.

The method proved satisfactory because a very substantial number of replies were received listing 726 mechanically-cooled and 203 ice-cooled jobs. Thus, the total listed is 929. It is believed that they are actual plants known by local people, or recorded by reliable firms.

The returns were incomplete, as was to be expected. It is evident that the 929 plants are therefore not the total for the whole country. While any attempt to base estimates on the incomplete returns is not strictly allowable, still it is so desirable to have such an estimate that we have prepared one. It would seem that the returns can be taken to be a fairly true sample. If this is correct then numerical estimates can be readily made. If computed results are reliable they should check with any fairly well established independent figures. If they do check, this fact should tend to prove the reliability of the estimate.

Reports included a statement of the nature of building in which the plants are installed. As theaters were included on this list, they gave a chance to check the computed number of installations against an independently established figure for theaters. It has been estimated from several sources that there are approximately 400 theaters throughout the country which have cooling plants. The returns from our readers showed that they list 121 mechanically-cooled theaters and 26 ice-cooled ones. Adjusting the unreported cities on the basis of population, we compute that there would be 380 mechanically-cooled theaters and 45 ice-cooled. The total is 425. This agrees very closely with the 400 reported by other estimates. We believe, therefore, that the returns do represent a fair sample and that an estimate based on them is reliable.

On this basis we believe that the number of comfort-cooled buildings in the country at present is approximately as follows.

	Mechanical Cooling	Ice Cooling	Total
Homes	290	50	345
Offices	300	65	365
Stores	250	14	264
Restaurants*	69	14	83

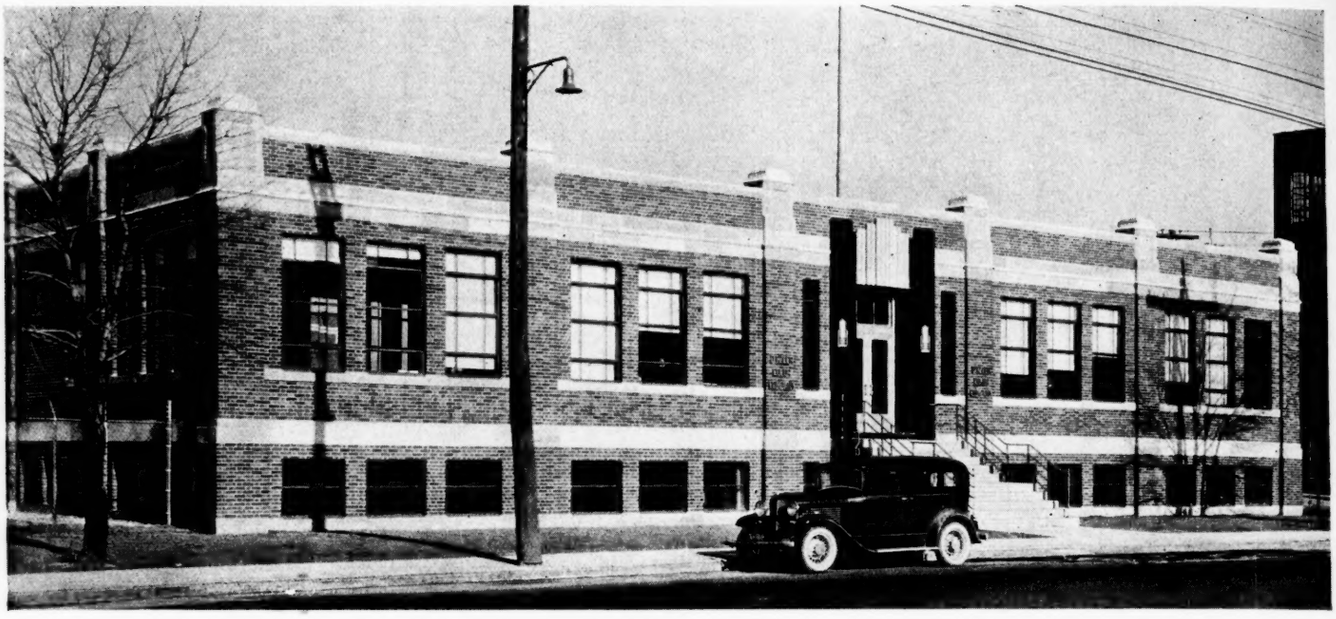
**Figures are incomplete.*

This indicates about 1100 buildings in four important groups which are expected to furnish by all means the greatest part of the market for comfort cooling.

Returns did not indicate how many of these buildings in each group are completely cooled. It is known, however, that some homes are cooled in certain rooms only, while most stores and restaurants occupy but small space in the buildings in which they stand. Certainly, in the great majority of such cases only the store or restaurant space is cooled. Few office buildings are wholly cooled. The returns must therefore refer to isolated offices, some of which are located in much larger uncooled buildings.

Neither do the figures show definitely whether any of the ice installations reported are of the portable type. It is believed that few if any portable ones are included for the form of the request for information usually brought back a note that they are not included. There is reason to believe that some hundreds of these units were in use last season. Whether this number runs into the thousands or not, we have no returns to show.

Indications are that, making all reasonable allowances both for large and small installations for both portable and fixed jobs, basement and room units, buildings both wholly and partially cooled, the grand total of comfort-cooled buildings in the country does not exceed 3000 at the present time.



Air Conditioning a Small Office Building

Heating, humidifying, cooling, and cleaning system in the office of the Ditzler Color Company

By J. J. MURRAY

CONTAINING one of the most compact and modern air conditioning systems in the Detroit area, the new office building of the Ditzler Color Company has been completed and occupied. The building, a one-story structure with sub-basement, as originally designed contained no air conditioning, but later it was decided to incorporate this desirable feature provided the addition required no rearrangement in the general layout of the building. The result was a uniquely compact installation obtained without sacrificing operating efficiency. Heated, humidified, or cooled by two conditioners, the air is cleaned as it passes through banks of canvas bag filters.

Temperature and humidity are automatically controlled from two control stations in the first floor offices. A supplementary exhaust system in the basement display room, used for sales conferences and meetings, will remove odors and smoke when necessary. Concealed extended-surface heaters flank the main entrance, while the side entrance and toilet rooms contain direct cast-iron radiation.

The two conditioners are located in the machine room, as are the heat exchanger (center foreground, Fig. 3), all necessary discharge and return air connections, the vacuum pump, motor drives, and domestic hot water heater. The ratio of space occupied by the equipment to that conditioned is 1:47.

Fig. 4 is a section through the machine room showing the location of the two units, looking toward the door. Each unit is driven by a 1-hp. motor through a V-belt drive. Being mounted on the concrete floor and separated from the units, no motor vibrations are magnified in the conditioner casings. Low air velocities in ducts and at discharge grilles reduce objectionable air noises.

For winter heating, hot water is circulated through the conditioner heating-cooling elements, while for summer cooling, water from the city mains is utilized. During the heating season, banks of sprays, built into the units, humidify the air. Summer water temperatures do not permit dehumidification during extreme weather, but the addition of refrigerating equipment, while possible, was not considered expedient under existing conditions.

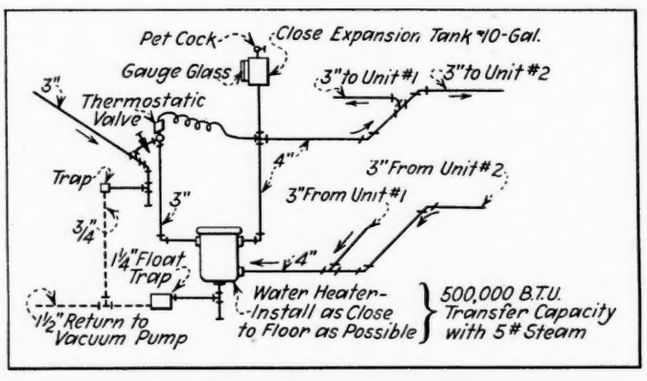


Fig. 1. Diagram of heater connections

The presence of an isolated steam plant on the property was a large factor in the selection of the conditioning units. Steam from this plant is brought into the machine room, passed through a thermostatic valve controlled by the water tem-

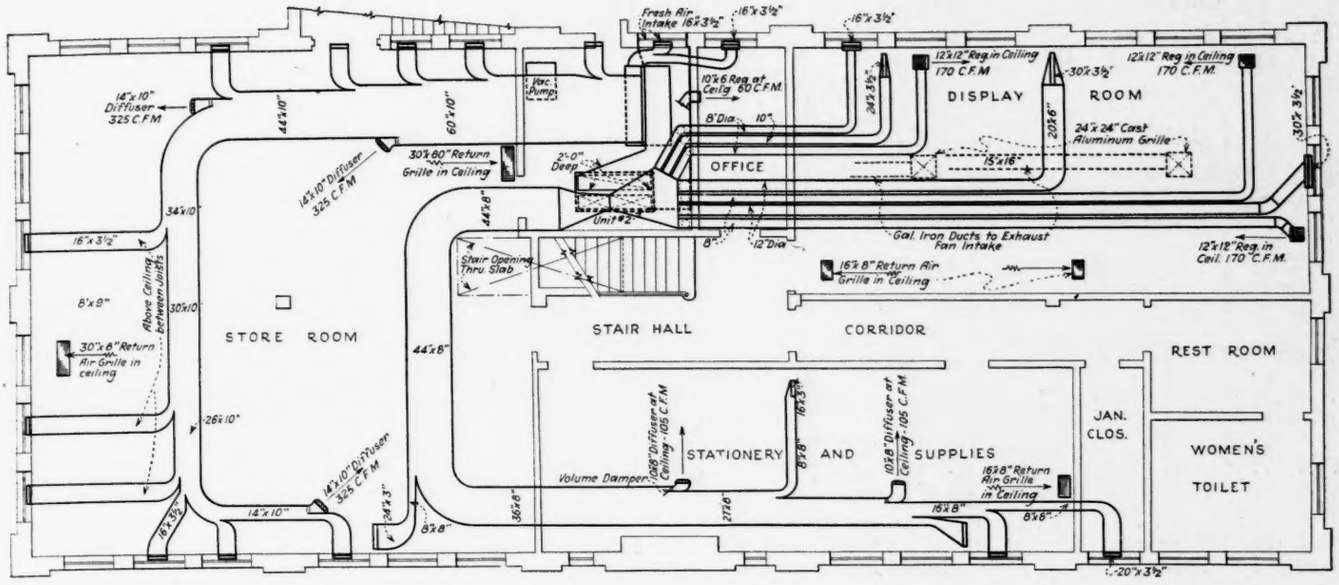


Fig. 2. Basement plan of the Ditzler Color Company Office Building showing arrangement of conditioners and ductwork. The latter is suspended from the ceiling.

peratures in the conditioner heating elements, and into the heat exchanger. Here the conditioner water, heated by the condensing steam, is circulated by gravity in a closed system through the heating elements, and returned to the exchanger. A vacuum pump handles the load on the heat exchanger and a small amount of direct radiation.

In the heating season, air passes through the filters, is warmed and then humidified before being discharged into the building. During the cooling season, some 700 hr. in the Detroit area, water from the city mains displaces the hot water, the change-over being easily made by means of a set of hand valves. This cold water, after passing through the conditioner element and cooling the air, is piped to the lawn.

In the main, all ductwork is constructed of galvanized iron and suspended from the basement ceiling. The ducts are uncovered, but sealed, no further insulation being necessary due to location. Supply ducts for the main floor offices branch up through the floor slab and are carried in the partitions to the point of discharge just above the wood-wall base. Conditioned air reaches the basement rooms through diffusers in the suspended ductwork.

The single exception to this procedure are the ducts supplying the display room and the two private offices immediately above it. These ducts are round and concealed in the space between the first floor slab and the basement ceiling. Seven in number, two supply air to each office and the remaining three serve the display room, discharging down from the ceiling.

The first floor slab is supported by open steel trusswork and is sealed on the bottom by the basement ceiling. This open space is utilized as a plenum chamber for the return air, eliminating costly ductwork. For the first floor offices, the return grilles were connected to this plenum chamber through galvanized iron sleeves set in the floor slab, as shown in Fig. 5. All the basement rooms are cut into the return side of the system through grilles in the ceiling.

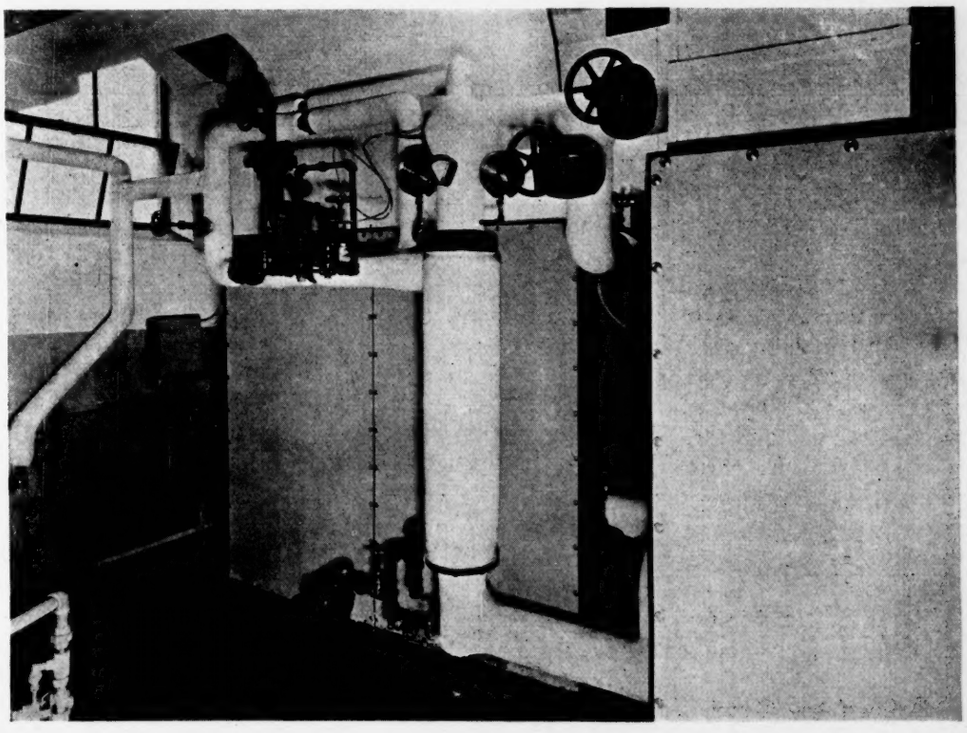
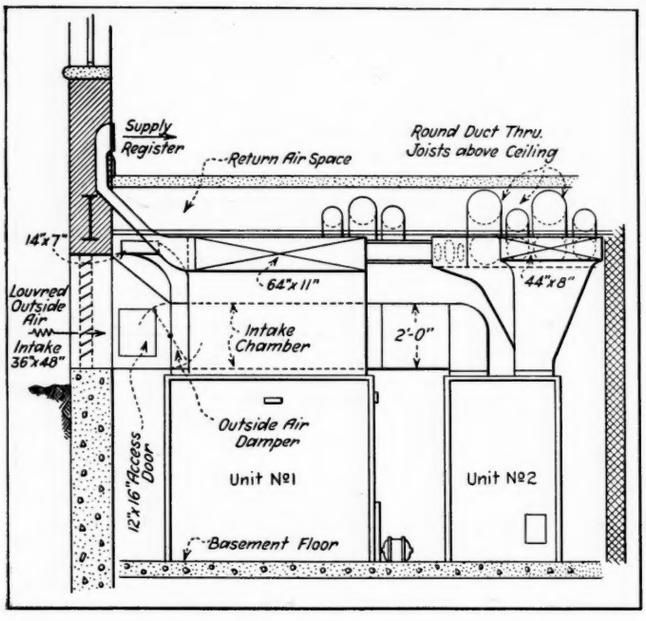


Fig. 3. Machine room showing the compact arrangement of the American Blower conditioner units.



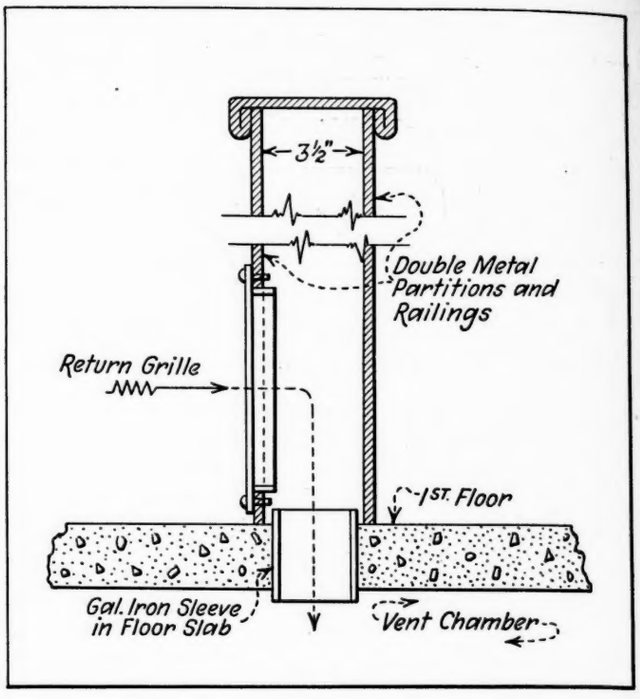


Fig. 4. (Above) Section through heater room
Fig. 5. (Right) Detail of return grille

A common intake chamber serves both conditioners and through this the return air is delivered. In addition, a large connection, dampered to this intake chamber, supplies outside air to the units when needed.

Both supply and return openings into all rooms are fitted with bronze grilles which provide a low resistance to air flow, are easily adjusted, and possess an attractive appearance, harmonizing with the interior decoration of the building.

The space to be conditioned was divided roughly into two equal zones, one for each conditioner. One unit serves the group of private offices on the main floor, and the stationery and display rooms in the basement. The general offices and sales quarters on the first floor and the storeroom in the basement are supplied by the second unit.

Each zone contains two control stations, this method lending flexibility to the system. The actuating device in the control unit is built into the conditioner, while the control panel, operating by remote control, is placed at the station. As it was difficult during construction to determine accurately the best location for the controlling panel, it was thought best to provide two likely stations in each zone. Thus, the portable control panel need not be permanently attached to one given location, but may be placed at the most available station.

The entire first floor ceiling, comprising all the offices, as well as the display room and the stair-well ceilings, are acoustically treated to reduce noise transmission. The sound-absorbing element is composed of a pad of mineral wool packed in a perforated metal panel. To reduce the cost of this acoustical treatment, a border of transite board surrounds the metal panels, the combination not only reducing the spread of noise, but also presenting a pleasing appearance.

The installation, first of its type in the Detroit area, was designed by Weston & Ellington, architects, and erected by Glanz & Killian, contractors.

Jugoslav Palace Has Central Heating Plant

ONE of the most interesting recent examples of central heating in Europe is that of the palace of King Alexander of Jugoslavia. Here seven separate buildings are connected to the district heating plant, the pipes between them being laid in underground passages. The royal palace, chapel, and the kitchens form one main group, with a sub-station in the passage between the palace and the kitchens. Other groups are the visitors' pavilion, barracks, porter's lodge, and the adminstrative buildings with stabling and garages. The volume to be heated is about 800,000 cu. ft., and the maximum amount of heat required at –4° is 3,000,000 B.t.u. per hr.

Water is heated in two batteries of hot-water boilers, each comprising four cast-iron sectional boilers arranged for burning lignite. The total heating surface is 2,150 sq. ft. Connected to these boilers is a further battery of three boilers with a total heating surface of 800 sq. ft. for heating the hot water required. Two motor-driven low-lift centrifugal pumps circulate the heating water through a distributor equipped with the necessary valves and measuring instruments, to the mains leading to the various buildings. One pump works continuously, the other serving as standby.

The tunnels between the separate buildings are 4 ft. wide by 4 ft. 6 in. high, and are lighted by ceiling windows. The heating and hot water supply mains, and also the electric cables, are laid in these passages. In all the royal buildings the piping is concealed in flooring ducts, the risers being led up recesses cut in the walls. All pipes not actually used for radiating purposes are heavily insulated. The total heating surface of the radiators and coils is approximately 20,500 sq. ft.—*A. C. Blackall.*

What Does Summer Cooling Cost?

An analysis of operating data for cooling equipment in small and medium-sized buildings

THERE is an unfortunate dearth of published information on the operating costs of comfort cooling equipment in small to medium-sized buildings. This is attributable in part to the newness of the art. Moreover, but few plants have operated for any length of time under complete owner control. The following summary collects together what information is at hand and notes how these costs agree with those found by computation.

Computations of expected cost are not difficult but are necessarily unsatisfactory both because of the assumptions which must be made and also because of the wide variation found in the dollar costs of equipment, installation, water, electricity, gas, and ice.

In some places an adequate supply of cooling water is available at a charge as low as 20 cents per 1000 cu. ft., while in other localities this same quantity costs as much as $4. So, too, the cost of electricity varies from as little as 2 cents per kw-hr. to as much as 8 cents. Where there is such a range of price, obviously there is no point in any elaborate calculations.

Costs Estimated

With electrically-powered refrigeration on the basis of 1 hp. of electric power per ton of cooling effect and a 10° rise in water temperature, electric costs are found to range from 1.5 cents to 3.7 cents per hour of operation per ton of refrigerating effect and water costs range from ½ cent to 9.6 cents. These are actual out-of-pocket costs which must be paid currently. So, also, are auxiliary power costs and incidentals which are computed at ¾ cent to 1¾ cents per hour per ton. With a favorable combination of prices the monthly bills for water and electricity might run as low as 3 cents per hour per ton, while an unfavorable combination would run them as high as 15 cents. On a 400-hr. season the yearly cost of operating would thus be from $12 to $60 per ton of effect.

Fixed costs enter into the problem but they are not a direct out-of-pocket expense to be met periodically. While they should be charged in for accounting purposes it is doubtful if they actually are in many cases. A common practice is to allow $150 per ton per season. If this is charged off against a 400-hr. operation, the hourly fixed cost is 37½ cents. Adding this to the operating cost gives a range of from 40 to 52½ cents per ton per operating hour. This brings out the importance of the fixed cost item where it is used, and also how greatly the hours of use per year affect the hourly charge.

Where ice is used for cooling the out-of-pocket monthly charges are those for ice and for incidentals and auxiliary power. Auxiliary power and incidentals cost from ¾ cent to 1¾ cents per hour per ton of effect. Ice is quoted at from $4 to $7 per ton delivered. This is equivalent to from 16.6 to 29 cents per hour per ton of effect. Under favorable conditions the hourly out-of-pocket costs would thus be 17½ cents, and 31 cents under an unfavorable combination of prices. Investment costs with ice are usually less than with mechanical refrigeration, and on a 400-hr. season should run from 15 to 25 cents per hour per ton of effect. Total hourly costs should then range from 32½ to 56 cents per ton.

Reported Costs

So much for computed costs. Now let us see how reported results line up with these figures.

Data on power consumption in two residences in Washington indicate that from 535 to 710 kw-hr. per ton per season of 335 hr. were consumed, while for a 200-hr. season at Albany it varied from 375 to 400 kw-hr. These figures are equivalent to an average power use of 1.6 to 2.1 kw. per ton per hour of seasonal operation in Washington, and from 1.9 to 2.0 at Albany. These figures are in fair agreement with each other. In fact they agree more closely than would be expected from examples selected at random. No data are reported from which other unit consumptions can be computed.

Another piece of data comes from the operation of a mechanical cooling plant in a men's furnishing store in a middle-western city. Here the operating costs are reported to have been 5.7 cents per ton per operating hour.

Ice Cooling Data

Two fairly complete investigations were made during the summer of 1932 in ice-cooled residences located in Detroit, Mich., and Urbana, Ill.

The two plants were similar as to type, consisting of an ice tank from which chilled water is circulated to an air cooling coil installed in the duct system of an existing forced air heating plant. The tests were conducted primarily with a view to determine the most efficient and economical operation, rather than to adhere strictly to the accepted prescribed conditions.

The Urbana residence is of standard frame construction with copper roof, and wall sections consisting of weather boarding, building paper, 2 in. × 6 in. studding, wood lath, and plaster with rough sand finish. Space cooled amounted to 14,170 cu. ft., involving a cooling load of approximately 33,500 B.t.u. per hr., or about 2.8 tons, with an outdoor-indoor temperature

differential of 20° on the most severe day of the summer. All air was recirculated, and a thermostat was used to maintain the desired dry bulb temperature in the rooms.

Power consumed by the fan and pump motors was practically constant during the hours of operation, and amounted to ¼ kw. and 1¼ kw., respectively. Separate determinations indicated a practically constant basement loss of 6600 B.t.u. per hr., or about 0.55 tons. This indicates a total requirement of 3.35 tons of refrigerating effect for the 20° temperature differential, or a meltage of 280 lb. of ice per hour. Actually, the maximum hourly meltage rate observed was 220 lb., and the greatest 24-hr. meltage was 4,243 lb. It was concluded from the tests that the equivalent of 2 tons of ice must be melted in 24 hr. to maintain an effective temperature of 72° in such a structure when the outside temperature is in the neighborhood of 100°.

In the Detroit residence approximately 17,200 cu. ft. of space were cooled. This building was also of standard frame construction, with flexible insulation between the attic and floor joists. During the early tests, indoor temperatures of 75° to 77° were maintained in the face of outdoor temperatures around 95°, with a resulting use of ice at a rate of from 1000 lb. to 2500 lb. per day. It was found, however, that for this application at least, such a degree of cooling was unnecessary, and required an ice consumption entirely out of proportion with the slightly increased comfort obtained as compared with a slightly higher indoor temperature. Tap water was circulated in the coils at times when the cooling load was not heavy, and the cost of this water is included in the cost of the ice. On a day when moderate cooling was required, 535 lb. of ice was used, with the apparatus in operation for 4½ hr., starting at 2:30 p.m. On this day the inside temperature averaged 74.8° for the 24 hr. with an average outside temperature of 80°, which rose to a maximum of 91° during the period. Average power input to the fan and pump motors was 0.84 kw., and the total power used was 3.78 kw. The cost of cooling, figured on the whole 24-hr. day, amounted to 535 lb. ice @ $5 per ton, or $2.14, plus 3.78 kw-hr. @ 2¼ cents, or 8½ cents, a total of $2.22. The hourly operating cost is therefore $2.22 ÷ 4½ or 50 cents. Operating data are tabulated below:

Total number of hours when artificial cooling was used	135
Total equivalent amount of ice used	18,166 lb.
Average ice consumption per hour of actual operation	135 lb.
Temperature, during days of artificial cooling	
Maximum inside temperature at any time.	80°
Average inside temperature	74.7°
Maximum outside temperature	95°
Average outside temperature for 24 hr.	77.8°
Average outside temperature for cooling periods	83.7°
Average dry bulb temperature difference between indoors and outdoors during hours of operation	8.1°
Average effective temperature difference between indoors and outdoors during hours of operation	6.2°
Power Use	
Electricity used per ton of ice melted	10.4 kw hr.
Costs	
Ice (including equivalent of city water) 9.08 tons at $5 per ton	$45.40
Electricity 94 kw-hr. at 2¼ cents per kw-hr.	$ 2.12
Total operating cost	$47.52
Average total cost per day when cooling was used	$ 2.16
Average cost per hour of actual operation	$ 0.352

It will be noted that the figure of 35 cents per operating hour for this plant with a reported cooling load of 33,000 B.t.u. would compute to nearly 13 cents per ton per operating hour—a figure closely approaching the lower one found by computation.

Costs Compared

Following are the comparative operating costs for the several different methods of cooling as calculated for Detroit:

	Ice	Water	Electricity
Unit cost	$5 per ton	$0.20 per 1000 gal.	$0.0225 per kw-hr.
Heat absorbing capacity	344,000 B.t u. per ton	50,000 B.t.u. per 1000 gal. Initial temp., 58° Discharge temp., 64°	10,236 B.t.u. per kw-hr.
Cost per 1000 B.t.u. of cooling effect	1.45 cents	$0.40	$0.22

It was noted in both the Urbana and Detroit tests that it is impractical to hold a large differential between outdoor and indoor temperatures when the outdoor temperature is falling, as it would require a much increased ice consumption to reduce the indoor temperature at a rate commensurate with the rapidly falling outside temperature, due to lag between outside and inside temperatures. The use of awnings on the sides of the houses exposed to the direct sunlight was found to reduce the cooling load by as much as 20% to 30% on days when the sun shone brightly. It was also found that if provision could be made to draw in outside air at such times when the outdoor temperature is lower than that of the indoor temperature, the time of starting up the cooling system can be deferred considerably on the following day.

Observations made at the Port Huron office of the Detroit Edison Company indicated that to maintain an inside temperature of 80° at 40% relative humidity when the outside conditions are 95° and 50% relative humidity, requires a total cooling load of 214,990 B.t.u. However, as the building is shielded from the sun shortly after noonday, this load is considerably reduced during the afternoon, and the melting of 7000 lb. of ice in 8 hr., equivalent to 11.66 tons of refrigerating effect since the melted ice water rises to 55° in the coils, carries the load on a typical hot day. Ice for this system costs about 37½ cents per ton per hour of operation, exclusive of power for fans and pumps, no data for which are available. The total operating cost for the season for this plant is given as $1187, to which fixed charges of $917 are added, bringing the cost of the season's cooling to $2099.

Silica Gel Conditioning

Various summer air conditioning systems involving the lowering of the effective temperature through dehumidification accomplished by some dehydrating agent along with a reduction of the dry bulb temperature have given satisfactory results and show considerable promise. Most interesting of these at present is the silica gel process of dehumidification as used in connection with gas-fired forced air heating plants. Briefly, this process consists of the removal of latent heat from the air by a mechanical absorption of moisture from this air by passing it over beds of silica gel. The latent heat thus removed appears as sensible heat which is subsequently removed from the air by passing it over cold water coils in an after cooler. Recirculated air is likewise cooled in a main cooler and filtered before being discharged back into the living quarters. The silica gel beds are reactivated by alternately passing heated air through the moisture-laden sections which are rotated into position for dehumidification and reactivation so that the process is continuous and automatic.

Operating figures for a silica gel system in a residence, in which 25,000 cu. ft. are conditioned by this process, are available. The installation has a nominal cooling capacity equivalent to 5 tons of refrigerating effect. The following results were obtained on three hot days during August, 1932:

Maximum outside temperature...	84°	94°	99°
Maximum inside temperature.....	80°	81°	83 5°
Minimum inside temperature.....	76.5°	79°	79.5°
Maximum outside relative humidity	82%	82%	61%
Maximum inside relative humidity	50%	53%	55%
Minimum inside relative humidity	38%	46%	49%

Average hourly operating quantities for this typical installation were as follows:

Gas (530 B.t.u. per cu. ft.).....	110 cu. ft.
Water	32.5 cu. ft.
Power.....	1.27 kw.

Using assumed rates, the average hourly operating costs are calculated to be:

Gas—110 cu. ft. @ $0.75 per 1000.....	$0.0825
Water—32.5 cu. ft. @ $1.00 per 1000.....	0.0325
Power—1.27 kw-hr. @ $0.03 per kw-hr.	0.0381
Total	$0.1531

This represents a cost of about 3 4/5 cents per operating hour per ton of refrigerating effect. Assuming 700 hr. as an average seasonal operating period, the annual cost of summer cooling by the silica gel method at the above rates figures to $106, exclusive of the fixed charges, no data for which are available.

Published data are at hand for seven other tests of this type of equipment, made in various localities throughout the country which should provide a good general basis for estimating costs. The equipment and process in each case were substantially the same as that described in a foregoing paragraph, with the exception of that in a test house in Dallas, Texas, where cooling water for the after cooler was obtained from a convenient spray pond in the rear yard, and an induced draft cooling tower in the basement removed heat from the main cooling water. This eliminated the water item from the operating costs, but materially added to the power consumption. Data for the six tests in which tap water was used for cooling follow:

	High	Low	Average
Conditioned space, cu. ft.....	24000	19300	22183
Gas cost per 1000 cu. ft. of 540 B.t.u. equivalent	$0.78	$0.43	$0.59
Power cost, per kw-hr.	$0.05	$0.0312	$0.0404
Water cost, per 1000 cu. ft.	$4.00	$0.51	$1.77
Operating costs, per hr.:			
Gas	$0.0925	$0.047	$0.0735
Power	$0.0885	$0.325	$0.0701
Water	$0.1730	$0.0316	$0.0755
Average total operating cost, per hr.	†	†	$0.2191

†The high cost gas did not necessarily apply to the same job as the high cost water, etc., so that the total high and low would be meaningless.

Average operating costs for the Dallas test plant, conditioning 19,700 cu. ft. of space, were found to be:

Gas—120 cu. ft. @ $0.351 per 1000 cu. ft. 540 B.t.u. gas equivalent	$0.078
Power—4.4 kw-hr. @ $0.022.....	0.094
Total.....	$0.172

Assuming the capacities of all these plants to be about 5 tons, the average hourly operating cost per ton for the six residences cooling with tap water is about 4½ cents, and for the Dallas house about 4 1/3 cents.

Other Factors

Evidence presented by these recorded cases would indicate then that under the most favorable conditions of power, water, ice, and gas rates, and the most careful and economical operation, an *operating* cost of 3 cents per ton per operating hour may be expected for mechanical cooling, a cost of 13 cents per hour per ton for ice cooling plants, and an hourly operating cost of 4½ cents per ton for the silica gel system. It can readily be seen, however, to what extent the seasonal cost of cooling is dependent upon the prevailing weather conditions, the hours of operation, the use of such auxiliaries as awnings, ventilating fans, etc., and upon the judgment and skill of the individual responsible for the operation of the apparatus.

In this latter connection, it is readily understandable how personal preferences and reactions will influence the use of the equipment when we consider that civilized man has long accustomed himself to inhabiting quarters in which a fairly uniform condition, with respect to dry bulb temperature at least, is maintained during a major portion of the year and then, after the heating plant has been shut down in the spring, to accepting without question what comes along in the way of indoor weather. If the plant is to provide conditions that are at once satisfactory and still worth the additional outlay for cooling, some study must be made by the operator in order that he may acquire skill in controlling it.

Air Conditioning—The Lubrication Factor†

COMPRESSOR lubrication must be studied according to the type of machine and the prevailing means for circulating oil to the moving or contact parts. In the centrifugal compressor bearing lubrication will be of chief interest, ring oilers being largely used for this purpose. The reciprocating machine, however, brings in the problems of both bearings and cylinders, the one oil usually being called upon to serve throughout.

Lubrication, on the other hand, is not the only point of consideration for the effects of congealed oil in certain parts of the system, as well as admixture with refrigerant with consequent change in the physical nature of the oil must also be studied. This will be particularly true where refrigerants of chloride combinations are involved. The opinion of Kinetic Chemicals, Incorporated, with particular respect to freon (dichlorodifluoromethane) is of distinct interest in this regard:

"The lubrication of a freon-charged compressor is similar to that of a compressor using a refrigerant that is completely miscible with mineral lubricating oil, such as methyl chloride. Since freon and mineral oil are completely miscible, an oil of higher viscosity is required than when using a refrigerant that is not miscible with the lubricating oil.

"The proper selection of a lubricating oil can only be made after having obtained a clear understanding of the physical conditions under which the compressor and system is to be operated. Factors which must be taken into account are, bearing loads, rubbing speeds, type compressor (enclosed or open frame), type compressor (air or water-cooled), temperature of evaporater, type evaporator (flooded or dry expansion), etc.

"It must be recognized that a small capacity, low horsepower, slow speed, enclosed type, air-cooled compressor operating a flooded evaporator at temperatures well below the freezing point of water, will function efficiently with a very light, low viscosity and low pour point oil. While in contrast, a large capacity, high horsepower, high speed, water-cooled compressor using trunk-type pistons or an open frame, operating a flooded evaporator well above the freezing point will require a higher viscosity and higher pour point oil. Between these two extremes there will exist various combinations of conditions with the result that it is not possible or wise to recommend an oil of any particular viscosity, flash point, fire point, pour point, etc., to meet all of the various operating conditions.

"For large air conditioning compressors of the enclosed type, an oil of up to 900 viscosity, flash point approximately 475° F., fire point approximately 575° and a pour point of 0° to possibly 15°, may be used.

"Capacity and type of compressor (whether air-cooled or water-cooled) principally will determine the viscosity of the oil to be used, while the temperature and type of the evaporator (whether flooded or expansion) will determine the pour point. The flash and fire points must be consistent with good refining practices but they should be kept as high as possible to eliminate even a remote possibility of carbonization of oil in the presence of air or water or both.

"The lubricating oil for use with freon-charged compressors should be a straight run and properly refined mineral oil and obviously must not contain water, sediment, acid, soap, resin, or any substance not derived from petroleum, and must not form wax or gum in the presence of freon. Also, the oil must not corrode any metal used in refrigeration construction.

"The use of glycerine or ethylene glycol (not miscible with freon) is not recommended, as glycerine is highly hygroscopic and in addition has the tendency to become gummy or produce a sticky sludge on surfaces when the compressor or system is idle or when the lubricant is heated.

"Mineral lubricating oils must be thoroughly dehydrated, not because of any chemical reaction but for the reason that any moisture in the oil will freeze out and thus restrict the flow of refrigerant through the regulating valve."

Splash Oiling Systems

By reason of the enclosed nature of the reciprocating type of compressor adaptable for air conditioning refrigeration work, splash lubrication is suited to the requirements, especially where compressors of vertical design are employed, operating with refrigerants of the hydrocarbon or chloride type.

The principles of operation constitute distribution of the oil at each revolution of the crank, the level in the crankcase being maintained just high enough to permit the crank to dip and splash the necessary amount of oil to the cylinder walls, etc. Continued operation will result in the crankcase being filled with a lubricating vapor above the main body of oil, which will also insure adequate lubrication of main, wrist pin, and crank pin bearings. When recharging the case with oil the level must never be raised too high; otherwise, oil would be churned by the crank, bringing about such violent agitation as oftentimes to preclude effective precipitation of any impurities that may have gained entry. There would also be possibility of loss of lubricant past the piston rings, with subsequent entry of an excess of oil into the condensing and evaporating parts of the system, or increase in the rate of mixture with the refrigerant. This can be partly overcome by proper adjustment of the piston rings. Where the latter are not sufficiently tight, if the crankcase contains too much oil or agitation is too violent, the excess which naturally will reach the cylinder walls will tend to work past the rings.

†Abstracted from *Lubrication*, published by The Texas Co., New York.

Not only is it wasteful, but a detriment, for oil in the refrigerating lines will impose an added load on the oil separator. Furthermore, if by chance the oil is not of sufficiently low pour test there will be a possibility of its congealing within the system, to act as an insulator and reduce refrigeration to a marked degree. The presence of oil in the system may also cause a higher condenser pressure by reason of the vapor pressure produced by the oil.

Use of excess oil in a splash lubricated system will also involve the possibility of difficulty when draining and cleaning, especially where sludging has taken place. Churning of certain oils in a crankcase will give rise to sludge formation if they have not been very highly refined. In part, this is due to oxidation; it will be most probable where water is present or the oil is laden with foreign matter, such as dirt, metallic particles, or carbon.

It is, therefore, important to follow regular periods for cleaning, and to look carefully into the condition of the used oil, for this will very often indicate both the approximate suitability of the latter and the extent to which effective lubrication is being attained.

Pressure Lubrication

Larger types of vertical or horizontal refrigerating machines can be served by pressure lubrication with marked success. With such a system, more accurate control of the amount of oil delivered to cylinder walls and compressor bearings is made possible. On the other hand, it may require more equipment, piping, etc., frequent filling of the reservoir (where a mechanical force feed lubricator is installed) and more attention from the operator than where splash lubrication is involved.

One of the chief advantages of pressure lubrication, however, is the possibility of effective filtration or purification of the oil where there is provision for circulation, in the interest of reducing sludge formation.

Mechanical force feed lubricators can be used where compressor cylinders are to be pressure-oiled. Excellent economy will be attained by regulating such lubricators so that just enough oil is delivered to maintain the requisite lubricating films, with the least amount of excess to drain off.

On many types of machines it is good practice to lubricate internal and external parts individually. In other words, using the mechanical lubricator with perhaps three outlets for cylinder and stuffing box service and an independent gravity or mechanical pressure circulating system for all other bearings.

Pressure lubrication is especially adapted to cylinder and rod lubrication via the oil lantern, or oil recess within the piston rod stuffing box. By properly constructing a stuffing box with a lead to come from the lubricator, it is possible to operate the piston rod continually through a ring of oil. In this way effective rod lubrication, as well as sealing against pressure, can be maintained.

To lubricate the cylinder in addition, it is only necessary to deliver additional oil to the stuffing box lantern and provide a so-called overflow pipe to carry this to the refrigerant suction line adjacent to the cylinder. In effect, this is similar to the principles of steam cylinder lubrication, the refrigerating gas being impregnated with vaporized lubricant prior to its passage through the compressor.

Hand pump oilers can also be used for this purpose, but mechanical force feed lubricators are more positive and require less attention on the part of the operator.

Pressure lubrication in air conditioning service is especially adapted to the carbon dioxide compressor. This latter differs from the usual type of machine intended for service with methyl chloride, or freon, in that the higher pressures will require considerably heavier construction.

Cylinder temperatures will also be somewhat higher due to these pressures. For this reason, individual study must be given to lubrication and positive means for oil delivery. For such machinery the lubricant should be a straight mineral oil, having a low pour test, and a viscosity ranging from 100 to 300 sec. Saybolt at 100°, dependent upon operating conditions and the pressures involved.

It is interesting to know that mineral oil has no affinity for carbon dioxide, hence there is little or no possibility of its being carried over into the condenser unless it is atomized. This latter is not likely to occur, however, when the oil is suited to the requirements, and the machine has been properly designed.

On the other hand, to insure against an undue excess of oil passing over into the system, an oil trap is usually installed in the discharge line from the compressor.

Stuffing boxes are built similar to those on a double-acting ammonia compressor, with the exception that the higher pressures involved require more compartments to prevent leakage.

Pressure lubrication is the usual means provided for serving the piston rod and maintaining an adequate stuffing box seal. The same system usually serves the compressor valves and piston as well. The feeding of a suitable amount of lubricant to the stuffing box prevents loss of gas.

Flow of oil must be very carefully adjusted at all times, however, since the feeding of an excessive supply of oil may result in a certain amount of it passing to the gas relief line and thence into the system.

Ring Oilers

The ring oiler has been widely adopted by builders of centrifugal compressors, due to the comparative simplicity, cleanliness, the extent to which automatic lubrication is developed, the small amount of attention required, the economy, and the uniformity and regularity of oil distribution.

In construction such an oiler comprises a bearing housing which is built with a reservoir and a slot of sufficient width and depth to permit one or more rings or collars suspended from the shaft to revolve therein. As a result, with the revolution of the shaft, these elements, being subjected to rotation, will carry a flood of oil to the top of the shaft, from whence it is able to flow into the bearing oil grooves and clearance space to be ultimately distributed to the entire wearing surface.

After the oil has passed through the bearing, it flows out to the end or ends to be directed through a suitable return chamber which is part of the bearing housing, back to the oil reservoir below.

Oil which is carried to the top of any such bearing must be returned to the reservoir as rapidly as it is delivered by the ring, in order to avoid undue accumulation in the upper part of the housing. The same condition may arise if the oil is carried too high in the well, or if the ring rotates at too high a speed. This will cause a splashing and churning of the oil.

Ring oilers are not usually recommended for bearings below 2 in. in diameter, especially where high speeds are involved, due to occurrence of excessive slippage of the rings, and the possibility of foaming arising in the oil where reservoir capacities are limited.

Handling of oil in this manner is today regarded by many as the simplest adaptation of the most efficient method of lubrication whereby the bearings are flooded with a considerable excess of oil over the amount that would theoretically be necessary to furnish the requisite oil film. By flooding the bearing with oil the latter serves not only as a lubricant, but also as a cooling medium to carry away part of the frictional heat developed, thereby reducing the temperature of operation. If the oil reservoir in the base of the bearing has been properly designed and is of sufficient capacity, this overheated oil will have ample opportunity to rest and become sufficiently cooled after each circulation by contact with the reservoir walls, particularly if the radiation of the latter is not interfered with. Settling out of sediment and other foreign matter will also be facilitated.

Lubricating systems of this nature possess natural advantages in that the flood of oil which is constantly passing through the bearings tends to wash out any grit, dirt, dust, or metallic particles that may have gained entry, as a result reducing wear to a minimum. On account of this washing action of the oil, however, the reservoir will gradually tend to accumulate a certain amount of sedimentary deposits. Therefore, it should be flushed out and cleaned at intervals, the old oil being replaced with new or purified oil. This is especially important when such a system is new and core sand, etc., may be present. In such cases several frequent changes are recommended.

In addition to lubrication via the ring oilers, in the centrifugal type of compressor, the lubricating oil performs another function in that it serves to maintain an automatic oil seal against loss of vacuum.

Viscosity

In the lubrication of refrigerating machines, the viscosity or body of an oil must be considered with particular respect to the design of the lubricating system. In the enclosed crankcase type of compressor the operating temperature of the case also becomes a factor. In such machines splash lubrication is generally provided for. By reason of the severe service to which the oil is subjected due to churning, especially in the presence of a certain amount of refrigerant, it must be of the highest degree of refinement and of sufficient original viscosity to resist abnormal reduction in body when mixed with refrigerants such as freon.

In this regard it must be borne in mind that the one oil must lubricate the entire machine. Centrifugal compressors involve only ring-oiled bearings. On the other hand, in such machines the oil must also maintain an adequate seal against loss of vacuum. Viscosity, of course, plays a part in this respect just as it does in lubrication; it could normally be expected that marked reduction from the accepted standard of approximately 300 sec. Saybolt at 100° might seriously affect the seal-forming properties. Too heavy an oil, in turn, might lead to a decided increase in bearing temperatures on account of internal or fluid friction. This would cause reduction in viscosity of the oil film, and might also impair the seal.

In view of the fact that the viscosity or body of any oil is directly affected by temperature, this characteristic must be thoroughly understood wherever oils are to be selected to meet low temperature operating conditions.

It is a characteristic of most liquids to become thinner or more fluid when subjected to an increase in temperature. For the information of the layman, in the petroleum industry this is termed reduction in viscosity. It will be of further advantage to state that viscosity is regarded as a measure of the relative fluidity of an oil at some definite temperature of observation. In brief, it is that inherent property by virtue of which the flow of certain liquids will be retarded. It is possessed by all lubricating oils to a varying degree, depending on their source, range of distillation, and extent of refining or blending.

As a result, wherever abnormally high or low temperatures must be encountered, the operating viscosity of the lubricant must be given the most careful consideration. Simply because the temperature of the lubricant may be more or less controlled prior to application or circulation to the wearing elements is no criterion that its operating viscosity in service will be able to maintain an adequate lubricating film. Attention must be given to the operating temperatures, and the original oil selected with this in view.

This will call for the utmost care in the selection of the proper grade of lubricating oil for low temperature operation. Haphazard choice without adequate knowledge of the approximate operating viscosity of the proposed oil may be the forerunner of too great a variation in the fluidity of the oil in service, with oftentimes ineffectual lubrication of certain of the wearing parts.

In the reciprocating compressor the oil must be capable of serving both the cylinders and bearings. It should not emulsify to any great extent, for this might result in clogging of the lubricating system or impairment of refrigeration should it work past the piston rings and over to the refrigerating side.

Here as well as in the centrifugal compressor the seal and compression-forming ability is of great importance. If the cylinder wall and moving parts are in first-class condition, a straight mineral oil of from 150 to 300 sec. Saybolt viscosity at 100° has been found to be satisfactory.

The more worn and scored the cylinder walls and rings, naturally the higher must be the viscosity, commensurate with the pour test, to maintain the requisite seal and degree of compression.

Horizontal compressor cylinders will have a greater tendency to wear out of round than those of vertical machines. Therefore, such compressors will, in general, require a somewhat heavier lubricant. It is not advisable, however, to attempt to compensate for wear by increasing the viscosity too much, due to the possibility of emulsification, and contamination of the refrigerant as mentioned above.

Pour Test Indicative of Fluidity

Low pour test is one of the outstanding characteristics which must be indicated in lubricating oils intended for service in refrigerating machinery attached to air conditioning or comfort cooling systems. Obviously, the oil must remain comparatively fluid at the lowest temperature to which it may be subjected during operation. As a general rule these will be encountered beyond the expansion valve, in the expansion or refrigerating side of the system.

Pour test is a characteristic which is dependent upon the base of the oil, the manner in which it has been refined, and to some extent upon the viscosity. Oils for refrigerating service must, therefore, be studied from this viewpoint, in conjunction with their viscosity, for upon this latter property will depend the body of the film which must prevent metallic contact between the moving parts, and the readiness with which the oil can be circulated by splash or ring oilers.

The wax content will normally be the controlling factor in regard to pour test or relative fluidity at low temperatures. All petroleum products contain a certain amount of wax, some more than others. The wax content of paraffin base crudes is considerably more prominent than in the naphthenic series. It is also more difficult to remove during refinement. As a result, unless a paraffin oil has been especially dewaxed it will show a considerably higher pour test than a naphthenic product of the same viscosity.

This presence of wax is the cause of congealment when certain oils are exposed to lower temperatures.

Congealment will mean that a film of oil will be deposited on the inner surfaces of the refrigerating piping, to form more or less of an insulating medium which will prevent proper abstraction of heat from the compartment or medium which is to be cooled.

Oils Must be Free From Water

The possibility of congealment requires that consideration be given to water. It is essential that the oil at all times be practically free from water, otherwise this will freeze if carried over to the refrigerator coils, in which case it would probably remain in the system and result in a certain decrease in evaporative efficiency. For this reason, certain authorities regard the water-free requirement as one of the most important phases of the lubricating oil specification.

An oil, to be suited to this class of service, should have a pour test sufficiently low to insure continued fluidity at the lowest temperatures prevalent in the evaporating side of the system. It should not congeal on the inner surface of the cooling coil, and there should be sufficient viscosity throughout the range of operating temperatures to enable it to serve at all times as an effective lubricant for the moving parts, as well as an adequate seal for the piston rings and compressor valves.

Filtered Mineral Oils Most Suitable

For such service a straight mineral filtered oil, having a viscosity of from 150 to 300 sec. Saybolt at 100° will be necessary where the temperature in the refrigerating coil is below 5°. Above this temperature, however, an oil of somewhat higher viscosity will be required, according to certain authorities.

The purest grade of straight distilled mineral oil obtainable is always advisable in order that the above requirements will be adequately met. Oils of this nature will have a sufficient range of physical properties to lubricate compressors effectively under all normal operating conditions.

Simple, Accurate Infiltration Calculations

By O. J. KUENHOLD

CONSIDERABLE confusion seems to be prevalent regarding infiltration losses. It does not seem to be clearly understood how and where these losses occur and how to apportion room heat-input to offset them. This results, in some advocated methods, in allowing twice for a loss that occurs but once. A restatement of exactly what occurs when air filters through a house is therefore apropos, to form a background for the discussion to follow.

No filtration loss occurs from any room unless there is an actual exit of warmed air from the room. Cold air filtering into a room occasions no heat loss from that room. True, extra heat must be put into that room to offset the cooling influence of the infiltered air, but this added heat is not lost until the infiltered air has "drifted" across the house to leeward rooms and is exfiltered. Strictly speaking, there is no such thing as an *infiltration* loss. The loss of heat occurs upon *exfiltration* at the leeward side of the house, but the extra heat required to offset this loss must be put into the windward rooms where the infiltration occurs.

It is obvious that infiltration can occur only at walls

exposed to higher atmospheric or wind pressure than others. The infiltration through well-constructed residence walls is so slight that it may be disregarded entirely. The only sources of infiltration to which we need pay attention are windows and outside doors located in walls exposed to commonly prevailing winter wind pressure. The infiltration occurring in any room and the extra heat-input which must be provided are therefore proportional to the door and window exposures in windward walls.

The methods employed for calculating filtration losses have gone through an evolutionary process which is of interest. Years ago, this loss was estimated, or rather, "guesstimated," by simply adding a percentage to the heat transmission losses of the room—although filtration losses are not influenced by or proportional to the transmission losses of the room. Later came the air change method which employs the cubic contents of a room as a base—still widely advocated; yet infiltration loss is in no way determined by the cubic contents of a room.

More recently the crack method was advanced. This begins to be of scientific basis but, as we shall show, it still requires refinement. Comprehensive tests enable the volume of infiltering air to be determined with fair accuracy. From its volume and temperature the required extra room heat-input can easily be calculated but the infiltration occurring has a considerable modifying effect upon other window losses, which is overlooked.

A smoke test will quickly show that the air which blows through the cracks of sash windows does not blow directly into the room, but blows across and parallel to the window glass. In so doing the inleaking air forms a thin sheet or screen over a considerable area of the window, between the window and the air of the room. This screen prevents the air at room temperature from reaching and delivering heat to the glass. The percentage of the total window area thus screened depends upon width of crack and wind velocity.

The above action results in considerable reduction of the temperature of the air in contact with the inner-side glass area; hence, a reduction in thermal head and heat conduction. The loss due to the air infiltration is not altered by the above condition, but the loss in conduction of heat through the glass is materially reduced. The curtains and partly-drawn shades, which are used on almost all residence windows, facilitate the above action and the combined effect is to materially reduce the sum of the conduction and infiltration losses at windward windows. The higher the wind the greater is the reduction of the window conduction loss.

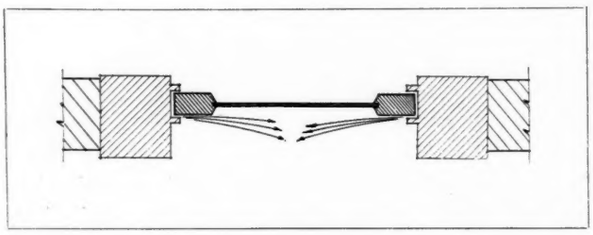
It follows from the above that windward window conduction and filtration losses cannot with accuracy be separately considered but should be considered under a single heading as "window losses." It is possible to reduce these losses to an average loss per square foot of casement opening. By observation of the relative glass area shielded by the sheet of inleaking air; the assumption of 1 ft. of effective crack length per square foot of casement opening; 60 cu. ft. of infiltered air per foot of crack, and certain other assumptions, the average combined conduction and leakage loss per square foot of casement opening has been determined by the writer at 125-130 B.t.u. for 70° of room heating. This was subsequently checked by observation as to satisfactory heating of rooms, the losses of which were calculated on that basis.

At leeward windows, the conditions are somewhat different. Here the air exfilters, traveling in the same direction as the conducted heat flow. But before the air exfilters, it is cooled, by vicinity to the window, to a temperature less than the average temperature of the floor air returned to the radiator or cold air return grille, as the case may be. A certain portion of the air, which, in the absence of exfiltration would become cooled by the window and descend to the floor, will be cooled and then exfiltered. The floor air returned to radiation or furnace will therefore be at somewhat higher temperature during exfiltration, and the required heat-input of leeward rooms may actually be reduced by exfiltration.

A careful examination of the total losses at leeward windows indicates losses of about 65 B.t.u. per sq. ft. per hr., but on account of possible "breathing," unexpected wind pressure due to wind eddies caused by surrounding of the house, or wind from unusual direction, it is best to assume 80 B.t.u. per sq. ft. per hr. as the loss. All losses mentioned are for 70° temperature difference between rooms and outdoors. The reserve capacity of the heating plant should take care of the effect of excessive winds.

At outside doors, the cracks are such that inleaking air blows directly into the room, but as the running feet of crack length per square foot of door area is less than in the case of windows, and as the heat conduction through doors is approximately half that of windows, doors may be regarded the same as windows.

It is quite possible that the loss due to infiltration through plain brick windward walls may not be as great as usually calculated. The infiltering air travels toward the inner side. The heat flow is in the opposite direction. The moment the heat enters the wall it is lost so far as the room is concerned; but the inflowing air is gradually warmed by the outflowing heat and when it escapes into the room it has been warmed to the temperature of the inner wall surface. In other words, it brings back into the room part of the heat which has been lost into the wall. This process no doubt increases wall conduction. The question is—how much is the wall conduction increased? It is possible that the increase in conduction is considerably less than the loss usually assumed as due to infiltration. Only actual tests can determine this.



Plan view of window, showing how inleaking air blankets the cold window from room air

EDITORIALS

Watch the Room Cooler

This is the active season for the installation of the new lines of room coolers which have made their appearance in the past year or two. Surveys and reports have shown clearly that last season was disappointing. Latest reports are that following the recent hot spells these units came into sudden demand. Apparently they will make their first serious bid for acceptance during the present summer. By the end of the season we should be able to get an inkling as to just how rapidly acceptance of individual direct cooling is going to be. Up to now, opinions have been about the only guides, and unfortunately opinions have been sharply divided. An instance was the occasion of a recent utility meeting in Chicago, when, with several speakers assigned to outline their views, each expressed widely differing opinions. One felt that cooling was not yet in a fit state of development for the utility companies to promote, another was enthusiastic in urging its promotion at once. The story will not be complete until we learn how the installations actually perform on the job. With good results from the present season, room cooling may come along with unlooked for speed.

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Under New Rules

Without doubt the new industrial recovery act offers the greatest opportunity for real leadership which has ever been presented. Removing the restraints of the anti-trust laws and permitting industry to act under its own leaders and with rules of its own making is a new experience. We all know well of some of the trade practices which have been so bitterly complained of in our own industry. Price-cutting, bid-peddling, chiseling, and using the money from the present job to pay off the debts of the previous one are too common occurrences for anyone not to know of them. Many a lament has gone up that these practices are unfair, and ways of escape have been discussed. Now there is an opportunity at hand to do something about them.

In our opinion it is an open question, however, whether we ourselves will ever realize anything concrete from the chance offered. We believe, too, that our chances depend almost altogether on the quality of leadership which is forthcoming. Heretofore, industrial leaders have been those who could drive the sharpest bargain—not those who could best act with far-seeing vision in the common good. The two-fisted go-getter has been our ideal. He was no compromiser.

Now a new situation is upon us. Codes of fair practice are necessary in operating under the new act. To be fair to all concerned it is almost inevitable that they will have to make concessions to the other fellow. They will have to be drawn in a spirit which recognizes the right of other interests to compete; otherwise, they cannot be codes of fair practice. A spirit of compromise must be abroad. We believe that this fact must be recognized and that a new type of industrial leadership must be built up around it. If this spirit is present and if our leaders are imbued with it we may get somewhere in taking full advantage of the opportunity.

Ours is a peculiar industry in many respects. It has never been fully integrated, overlaps into others, and has tended toward decentralization. Where trade associations have been organized they have usually taken notice of only isolated parts of the whole industry. There is a wide variance among the selling methods employed in the several branches. With conditions as they are it is hopeless to expect that the whole industry will suddenly forget its past practices and draw itself together as one unified group. This makes our problem more difficult and makes the task of working out suitable codes more troublesome. Already, moves are under way for formulating codes for each small group. To expect agreement among them is too much. The real test will come with the first clash of interests. There, too, will come the real test of the several leaderships. Let us hope that they are able to rise to the opportunity and to recognize it fully.

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The New Deal and the Building Industry

The building industry is among those predicted to receive the greatest benefits from the "new deal" legislation. Provision of funds for federal buildings and to permit the financing of local projects is included. Supporters confidently expect to see major undertakings under way within 90 days. These include some on which work has stopped under the economy orders of the early spring. On many of these, orders for material were already placed when the halt order was issued. Resumption will change these frozen orders into active ones. This will certainly help to brighten the picture.

Another of the measures from which help is expected is the home loan act. It will no doubt take considerable time to make its effects felt. In the long stretch, though, the credit released from liquidating the loans on homes placed during the boom period can be definitely calculated to look for re-employment and some of it will find its way back into building mortgages. Actual inability to secure finance for building is at the bottom of the troubles of the industry and any means —no matter how indirect—of releasing credit frozen in building loans is just so much help in getting the whole building industry back to a point where it can start to operate normally again.

As the "new deal" has worked out to date it appears that we have received what looks like a good hand, with some short range prospects and with some which will take a considerable time to produce results.

Your Everyday Problems

HEATING AND VENTILATING will be glad to answer your problems relating to installation and operation of heating and ventilating systems. Letters will be answered promptly, and in some cases published anonymously. If sketches are included they should be clearly drawn. Write The Editor, HEATING AND VENTILATING, 148 Lafayette Street, New York.

QUESTION 88. *Is it advisable to insulate the return line to the receiver of a vacuum pump?* *J. H. T.*

ANSWER. There is no necessity for covering the return line in a vacuum system, and its use may lead to serious operating troubles. Heat lost from the return piping simply adds heat to the building, and is therefore not wasted. On the other hand, if too high a temperature is maintained in this line, the water may flash into steam when the pressure is reduced, interfering with the operation of the pump.

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QUESTION 89. *What is to prevent condensation from forming on the outside of window panes when a cooling system is in operation within a building on days when the outside temperature is extremely high and a high relative humidity prevails? It would seem that this annoyance might occur during the summer as well as in the winter when a high relative humidity is maintained indoors with a low temperature outside.*

P. J. K.

ANSWER. While there is a remote possibility that with a very great reduction of inside temperature by means of air-cooling apparatus some condensation might take place, it is so highly improbable that weather conditions would ever combine to make it possible, that it would never constitute a problem. Since it is seldom practical, or indeed healthful, to maintain an inside temperature at a point lower than 10° to 15° less than the outdoor temperature, even on the warmest days, the temperature of the outside surface of the glass will never be more than a few degrees below that of the outside air in contact with it. For condensation to take place, therefore, the relative humidity out of doors would have to approach very closely 100%, and would have to occur simultaneously with an extremely high temperature at a time when there is very little air movement.

Relative humidities in the neighborhood of 100% are rare, and occur generally on cloudy or rainy days. On the other hand, extremely high temperatures are not generally recorded on sunless days. Examination of climatological data for any locality, as recorded in HEATING AND VENTILATING's weather charts (New York will serve as a good example because hourly relative humidity readings are recorded here), will reveal that the hottest periods are accompanied by a relatively low relative humidity. That is, the dips in the relative humidity line correspond to the peaks in the temperature record. This is explained by the fact that for a given constant absolute humidity, the relative humidity decreases when the dry-bulb temperature increases.

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QUESTION 90. *A multiblade-type fan installed in the exhaust duct ventilating a small high school auditorium has developed considerable vibration, and the resulting noise is conveyed to the room through the duct. The fan is rated at* 7500 *c.f.m., and is directly connected to an induction motor which drives it at approximately* 1750 *r.p.m. Neither the fan nor the motor bearings show undue wear, and careful attention is given to their lubrication. There is no evidence of binding, and apparently no contact between the rotating parts and the casing, as the fan can be freely turned over by hand. Can you suggest the cause of our difficulty?*

R. M. B.

ANSWER. It would appear that the fan has been thrown out of balance in some way, so that when it is turning at high speed uncompensated inertia forces set up noisy vibrations. If the condition did not exist at the time of installation, it is likely that the fan has been damaged since it has been in use so as to destroy the accurate dynamic balance with which it left the manufacturer.

It may be found that the shaft has been bent. This can be discovered by supporting the rotor on knife edges, and noting the position in which it comes to rest. It is also possible that some of the blades have been damaged or lost. Another cause of vibration in fans has been traced to an accumulation of dust and dirt adhering to some of the blades at points where oil or grease has been accidentally dropped on them during lubrication.

The fan should be removed from the casing, checked

for these possibilities, and thoroughly cleaned before reassembling. Extreme care must be exercised in lining up the motor and fan bearings when the apparatus is set up.

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QUESTION 91. *What is meant by "crowd poisoning," and what are its effects? Does it result from a deficiency of oxygen in rebreathed air?* *F. M. W.*

ANSWER: Crowd poisoning is the name sometimes given to the ill effects experienced by individuals occupying confined and poorly ventilated spaces, especially when a considerable group is present. It is characterized by a feeling of depression, nausea, headache, and faintness, and in extreme cases, such as where large numbers of prisoners have been confined without circulation of air, has resulted in death.

Illness from breathing vitiated air is not so much due to a deficiency of oxygen in the air, as to a concentration of certain toxic organic materials excluded from the body through the lungs and skin. The exact nature of these poisons and the manner in which they react to the detriment of the victim is not clearly understood.

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QUESTION 92. *How is it possible for the occupants of a room warmed by a radiant or panel type heating system to be comfortable at an air temperature of* 65° *or less?* *M. J. L.*

ANSWER: Heat loss from the body of an individual in a panel heated space is largely confined to conduction and convection since the temperature of the surrounding heated surfaces is higher than the temperature of the surface of the body. Therefore, these surfaces absorb no radiant heat from the body.

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QUESTION 93. *Should an underground ice melting tank, supplying cold circulating water for summer cooling purposes, be insulated? What kind of insulation would be most suitable?* *W. F. L.*

ANSWER: It is general practice to insulate such tanks. As with other problems of insulation, however, the selection of insulation as to kind and thickness requires some study of the economics of the situation. There are several controlling factors to be taken into consideration, including shape of the tank, cost of ice, hours of operation, storage of ice, etc.

A rectangular tank erected in a concrete-lined underground substation, cooling a sales office of a midwestern utility, is covered with two layers of 2-in. corkboard, set in hot Mexican oxidized asphalt, and covered with a coating of cement plaster.

Where an ice tank is simply placed in the ground and covered over with earth, care must be exercised to waterproof the insulation. A manufacturer of this equipment recommends for this purpose a 2-in. covering of corkboard, cemented on, and covered with canvas. The outside should then be painted with several coats of a waterproof paint. Circulating pipes to and from the tank are covered with hair felt and similarly coated and painted. A felted insulation, applied in a similar manner, would probably be found more satisfactory for round tanks than would corkboard. The insulation should be applied with a cement or binding material that will not be affected by moisture condensing on the outside surface of the tank.

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QUESTION 94. *Does the rating of a steam radiator change if it is used in a relatively cold room, say one at a temperature of* 50°. *E. M. R.*

ANSWER. Yes, the heat transmission rate of a direct steam radiator is not a constant but varies with the temperature differential between the steam in the radiator and the surrounding air. For any given air velocity, the total heat given off by radiation and convection is expressed by the equation:

$$H = K(t_s - t_a)A$$

in which K is the coefficient of transmission, t_s is the temperature of the steam, t_a is the temperature of the surrounding air, and A is the area of the radiator in square feet. Therefore, it is seen that H will increase as t_s increases, or as t_a decreases. Actually the value of the coefficient K is not a constant, but varies as the differential $t_s - t_a$. For a differential of 150°, which is within the usual range in steam heating practice, K = 1.665, and its value varies between 1.425 and 1.815 as the differential ranges between 80° and 190°.

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QUESTION 95. *Is it common practice to install a check valve in the cold water supply line to a storage type water heater?* *W. A. H.*

ANSWER: The reason for installing a check valve in the cold water line is to protect the meter from destruction or injury from hot water forced back against the city pressure, and for this reason some water departments require it. However, if there is sufficient volume of water in the pipe line between the tank and the meter, it is exceedingly unlikely that water at a high enough temperature to cause damage will reach the meter.

When there is no check valve installed, back pressure against the city water head provides a simple and positive means of relieving excess pressure in the storage tank, and it is the consensus of opinion of a number of manufacturers of this type of water heater that the use of a check valve in the cold water supply should be avoided.

News of the Month

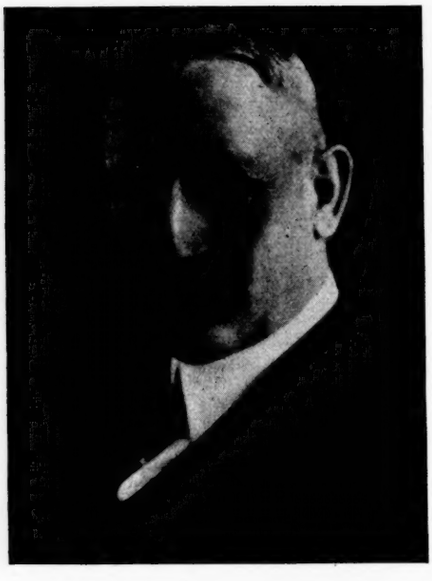
Oil Burner Men Adopt Industrial Rehabilitation Code at Chicago Convention

Virtually the entire oil burner industry has subscribed to a recovery code formulated in accordance with the Federal administration's national recovery act and adopted at the 10th annual convention of the American Oil Burner Association, Hotel Stevens, Chicago, June 12-16. About 7500 were in attendance, including 2000 manufacturers of burners and accessories, 1000 dealers, and about 4500 laymen.

Details of the code will not be revealed until after its presentation to the Federal government, but it is generally conceived to bring about increased employment, fair and adequate wages, reduced hours of work, improved standards of labor, and elimination of unfair and unethical trade practices in the oil burner industry. Morgan J. Hammers, president of the association, said in describing the code before the convention that no provision in it could be construed to promote monopolies, permit or encourage unfair competition, or oppress or discriminate against small enterprise.

Gilbert & Barker Mfg. Co., Springfield, Mass., and Braden Engineering, Inc., Providence, R. I., were received into membership in the association at the convention. Mr. Hammers was reelected to the presidency to serve a second term, and the following were elected vice-presidents: Haldeman Finnie, Timkin Silent Automatic Company; R. M. Sherman, Silent Glow Corporation; C. E. Campbell, Nuway Company; W. J. Smith, Cleveland Steel Products Company; R. S. Bohn, Preferred Utilities, Incorporated.

Also transacted at the convention was an agreement between power burner and range burner manufacturers to merge their marketing and distributing services in anticipation of an expansion of the use of oil in heating and cooking.



Morgan J. Hammers, reelected president of the A.O.B.A.

A. S. A. Adopts Code for Gas Piping

A code covering the installation, maintenance, and use of piping for city gas in buildings has been approved by the American Standards Association. The code was submitted by the National Fire Protection Association, and embraces practically every point of gas installation. Precautions to be observed by fitters are cited, and standard inspection and test methods are provided, including provisions to assure that gas-burning appliances shall be installed only where there are proper ventilating facilities.

Action on New York Building Code to be Speeded.

Early action to bring about adoption of a new building code for the City of New York to supplant the obsolete regulations now in effect has been promised by Mayor John P. O'Brien. The revision was prepared more than a year ago, and has been resting for some time with the committee on buildings of the Board of Aldermen. A delegation of the Merchants Association, which has spent three years and $60,000 of its own funds in preparing the new code, informed the mayor that delay in its enactment was holding up new construction in the city aggregating millions of dollars.

According to John Lowry, chairman of the association's building code committee, the code now in effect was drafted 20 years ago, and represents a serious handicap to the revival of building construction in New York, since under its provisions builders cannot take advantage of the economies to be realized from the utilization of the newer developments in construction methods. While changes have been made in the present code to bring it up to date with respect to steel stresses, floor loads, and elevators, no other major changes have been made.

Fitts to Head N. Y. Trade Ass'n Executives

Joseph C. Fitts, secretary of the Heating and Piping Contractors National Association, has been elected president of the Trade Association Executives in New York, N. Y., for the coming year. As vice-president of T.A.E. this year, Mr. Fitts has had charge of the planning of all programs of the group.

Former Heating Man Heads Public Works Program

Col. Donald H. Sawyer, chairman of the Federal Employment Stabilization Board, was named temporary administrator of public works by President Roosevelt, effective June

Donald H. Sawyer, who will have $100 million worth of building under contract by October

19, to take charge of administering the $3,300,000,000 public works program of the National Industrial Recovery Act.

It was indicated that within a few weeks Col. George R. Spalding, of the Army Engineering Corps., would be named permanent administrator.

Colonel Sawyer was for some time connected with the heating industry as secretary of the Heating Board of Trade of New York following its organization on January 8, 1930. He took office in April, 1930, but resigned early in 1931 to become chairman of the Federal Employment Stabilization Board. Previous to his connection with the Heating Board of Trade he was secretary of the Associated General Contractors of America, with headquarters in Washington.

Insulation Manufacturers Establish Technical Committee

A technical committee to deal with the technical phases of manufacture and use of fibre insulating boards has been established by the 11 companies comprising the Insulation Statistical Bureau. The committee is composed of E. C. Lloyd, chief engineer, Armstrong Cork & Insulation Company; R. T. Miller, chief engineer, The Masonite Corporation; E. W. Morrill, assistant to the general sales manager, The Insulite Company; C. K. Roos, manager, research department, United States Gypsum Company, and T. B. Munroe, The Celotex Company, chairman.

General functions of the committee include gathering and circulation of technical data, study of standards and specifications, obtaining of all building codes affecting use of fibre board industry, contacting various government departments in order to follow government technical specifications affecting the industry, and establishing contact with the various technical societies in related fields.

Cornell Continues as Ideal New York Manager

Ideal Furnace Co., Detroit, wishes to announce that contrary to the impression created in an item on these pages last month, J. H. Cornell, New York branch manager, will continue to have exclusive charge of the territory covered from the company's New York branch, with offices at 243 Graybar Building. This territory does not come under the supervision of A. H. Schroth, who recently opened offices at 1833 Federal Trust Building, Newark, N. J.

Air Conditioning Course Available for Heating Contractors

Under the auspices of its Committee on Air Conditioning, the Heating and Piping Contractors National Association has completed and published a series of 10 air conditioning lessons. The lessons are published in three parts.

Part 1, the first four lessons, presents in simple form the fundamental information and engineering data which the contractor needs in the development of the air conditioning market. Part 2, three lessons, deals with the making of an air conditioning survey, the design and layout of air conditioning systems, and the selection of equipment for use in summer cooling. Part 3, three lessons, concluding the series, deals with available apparatus and equipment, methods of selling them, and how to operate and service air conditioning systems.

The course has a total of 194 pages and, together with a durable three-ring flexible imitation leather binder, is available for $5.

Warm Air Heating Association Adopts New Name at Convention

At its mid-year convention, held at the Stevens Hotel, Chicago, June 6-8, the membership of the National Warm Air Heating Association voted to rename that organization the National Warm Air Heating and Air Conditioning Association. A registration of close to 200 was recorded.

The Tuesday morning session opened with a call to order and introductory remarks by W. L. McGrath, president, followed by a message of welcome to Chicago and A Century of Progress by an exposition official. Clarence A. Olsen then presented his paper, "Merchandis-

G.E.'S TEST HOUSE FOR AIR CONDITIONING

Located in Schenectady, N. Y., this residence, constructed for use as an indoor weather laboratory, will be occupied permanently by a few of the company's engineers who will operate the plant, keep records, and analyze data gathered in connection with residential air conditioning.

ing for Profit in Our Industry," followed by "The Insulation of Buildings, Theory and Practice," a paper by M. A. Smith.

The report of the Code Committee was presented by Prof. J. D. Hoffman, chairman. The second edition of the tentative code for the installation of mechanical warm-air furnace heating systems in residences as submitted at this meeting contains several important provisions not included in the first edition presented last year. Among these are a table for determining sizes for return air ducts, and considerable additional material to be used in selecting furnace sizes.

Tuesday afternoon was devoted to a meeting of the manufacturers of the association, over which W. G. Wise presided.

Wednesday morning session opened with a report of the Research Advisory Committee, by F. G. Sedgwick, chairman. A resume of the research work accomplished between December 1, 1932 and June 1, 1933 was then heard. This subject was introduced by Prof. A. C. Willard, University of Illinois, who was followed by Prof. Alonzo P. Kratz and S. Konzo, who described recent developments from the association's investigations, carried on at the Research Residence, Urbana, Ill. A report was heard on the study of automatic control systems as applied to coal-fired forced-air heating plants.

Wednesday afternoon was turned over to an open forum at which J. H. Van Alsburg discussed "Registers and Grilles for Mechanical and Gravity Systems," and L. R. Taylor spoke on "Rackets in our Industry." "The Opportunity for Air Conditioning in Replacement Work" was covered by F. E. Mehrings. Members were invited to add to the discussions and to ask questions. Reports of the officers and various committees concluded the day's business.

A conference relative to the adoption of certain standards of definition and performance for various types of air conditioning equipment, held on Friday morning, concluded the work of the convention. R. K. Jones, Newell-Emmett Company, Inc., New York, presided at this meeting and presented a plan for stabilizing the industry and protecting it from the damaging competition of irresponsible manufacturers whose equipment fails to conform to the recognized standards.

Register and Grille Manufacturers Merge

It has been announced that The Hart, Cooley, Highton Co., New Britain, Conn., (formerly The Hart & Cooley Manufacturing Company) and Tuttle & Bailey, Inc., Brooklyn, N. Y., have consolidated their manufacturing operations and sales facilities. The combination will enable the organizations to offer the trade a complete line of wrought steel and cast metal heating and ventilating grilles, registers, and accessories.

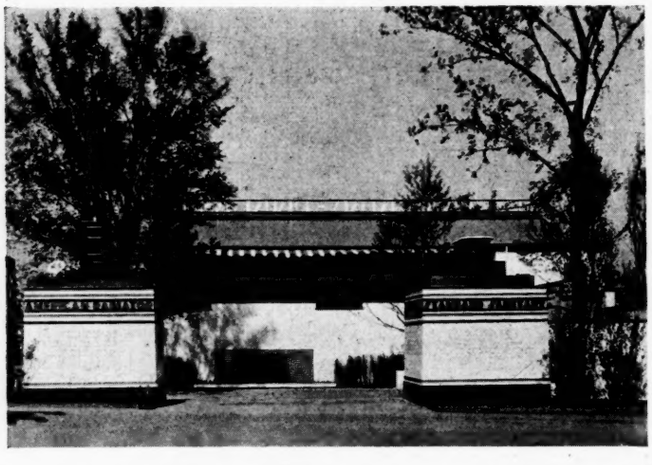
All contract business, including the manufacture and sale of ornamental grilles, will be handled by Tuttle & Bailey, while the stock register business will be handled in the plants of Hart, Cooley, Highton, at New Britain, Conn., Holland, Mich., and Fort Erie North, Ontario. The main sales offices will be maintained at 70 Berry St., Brooklyn, and at New Britain.

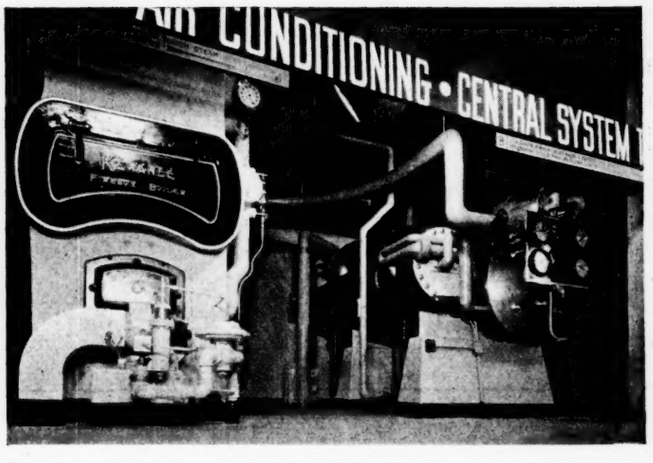
Long Island Burner Men To Have Outing

Arrangements have been completed for the annual summer outing and golf tournament of the Oil Heat Association of Long Island, to be held July 20, at the Brookville Country Club, Glen Head, Long Island. Dinner is scheduled for 6 o'clock, followed by a few short talks.

Radiator Manufacturer Investigates Modernization Results

To determine to what extent property owners have benefitted from installations of modern heating equipment, American Radiator Co., 40 West 40th St., New York, retained the services of a firm of accountants and engineers to investigate recently modernized apartments, and has published the reports of the survey in a booklet entitled "Modernization Tried."





Visitors to Chicago's A Century of Progress Exposition have found welcome relief from oppressive summer heat at the "Garden of Comfort," American Radiator and Standard Sanitary Corporation's pavilion at the fair. The building to the left houses a wide variety of indoor weather manufacturing products. The view to the right shows the boiler which supplies steam to the steam jet refrigerator from which cold water is obtained for cooling the exhibition building.

The book comprises a case study of 15 jobs, and in each case presents details of former and present operating and fixed costs, increase in investment and rentals, and shows the return on the investment. Illustrations, address, and a statement of endorsement by the owner are given in each case. The book is available on request.

Cordner Also to Represent Oil City Boiler Co. in New York

M. A. Cordner, vice-president and sales manager of the New York Office of The Titusville Iron Works Company, has also been appointed agent in the New York District for the Oil City Boiler Co., Oil City, Pa. The late Harry O. Dill formerly represented Oil City in New York.

Mr. Cordner's offices are located at 285 Madison Avenue.

Committee Rules on Water Feeder Connection

The Boiler Code Committee of the A.S.M.E., which rules on and interprets questions pertaining to the construction of boilers, recently passed on a case relating to low-pressure heating boilers and water feeders. The question put to the committee was: "Will it be permissible to connect an automatic water feeding device to the ½-in. water glass connection of a low-pressure heating boiler, provided there is no external use therein of steam or water from the boiler?" The committee's reply was: "Where a water gauge glass is connected directly to a steam boiler it is the opinion of the committee that no other connection should be attached to the gauge glass outlets. If a water column, or the equivalent, is used on a boiler, or steam and water connections are available for one, attachments may be made to the connecting piping for appliances that are not intended to provide for a normal external use of steam or water from the boiler unit."

McNair Resigns from U. S. Radiator

E. E. McNair has resigned as vice-president of the United States Radiator Corp., Detroit.

Keasbey & Mattison Move to Radio City

Keasbey & Mattison Company, manufacturers of insulation, moved its offices May 1 from 9 Park Place, New York, to the 12th floor of the R.C.A. Building in Rockefeller Center. The headquarters of the company is in Ambler, Pa.

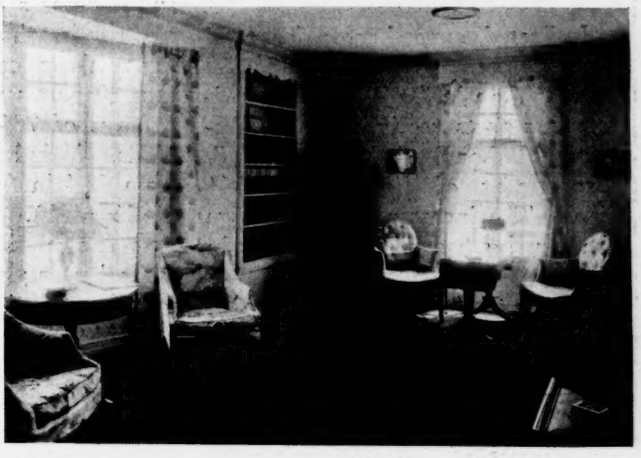
Majority of New York Buildings Under Seven Stories

In spite of its famous skyline, only 2.5% of New York's buildings are taller than 20 stories, according to charts on exhibition in the Manhattan Borough President's office. Buildings from one to four stories in height comprise 42.5% of the total, while those of from five to seven stories constitute 43% of the total. Land values in the Grand Central zone range from $400 to $10,000 per front foot, according to the maps.

Panel Heating for British Art Museums

Extremes of temperature in an art gallery constitute a danger to the preservation of pictures. Consequently, the new extension to the National Portrait Gallery is warmed by the panel system. The installation follows the successful operation of the system in the Duveen and the Mond extensions at the National Gallery and also in the Art Museum at the Hague, according to *The Heating and Ventilating Engineer*, London.

The question of the prevention of extremes of temperature in art galleries aroused considerable discussion in art circles, when it was reported some months ago that bubbles had appeared in Raphael's Ansidei Madonna at the National Gallery. The cause of bubbles, it was then stated, was exactly the same as that which resulted in more serious cracks, namely, changes in the temperature and humidity of the atmosphere. It was considered that although serious damage to a picture was unlikely to occur, it was not impossible. A well-known critic



"Tomorrow's House," the attractive modern residence pictured above, is both heated and cooled by steam from a new automatic coal-burning boiler which also operates the kitchen refrigerator, cools drinking water, and operates a clothes dryer in the laundry. The house was erected in Merion, Pa., for demonstration purposes by the Philadelphia and Reading Coal and Iron Company, which developed the boiler. The view at the right shows the interior of the living room.

claimed that prevention was better than cure and while the question of expense might constitute a difficulty, he felt that a nation willing to pay £72,000 for a picture should be prepared to spend what was necessary for its proper preservation.

Patterson Foundry Announces Appointments

The Patterson Foundry & Machine Co., East Liverpool, Ohio, announces the appointment of M. Edgar Yeager, 726 Chamber of Commerce Building, Boston, as its New England district manager of stoker sales. Skeldon Engineering Co., Toledo, Ohio, was appointed district representative in the Toledo territory.

R. C. Denny, formerly connected with Combustion Engineering Corporation, was appointed chief engineer of the company's stoker division.

Southern Dealers Appointed by Petro

Three dealers in the southern territory were recently appointed by Petroleum Heat and Power Co., Stamford, Conn., as follows: T. Price Samuel, 1042 Halifax St., Petersburg, Va.; J. J. McDevitt & Son Co., 7 South Richardson St., Greenville, S. C.; Vickers & Ruth, 214½ North Harrington, Raleigh, N. C.

Hill Represents Torrington

H. H. Hill, for the past nine years sales engineer for the American Blower Company, is now representing Torrington Manufacturing Co., Torrington, Conn.

Mueller Furnace Offices Moved to Plant

L. J. Mueller Furnace Co., Milwaukee, Wis., announces removal

Bright Spots in the News of the Month

N. Y. Employment Up in April

According to the New York State Department of Labor, employment in plants in that state manufacturing heating and ventilating apparatus jumped from 19.4 in March to 22.6 in April, the figures being in per cent of the 1925-27 average. Payrolls increased from 9.9% to 12.2% of the 1925-27 average.

Increases were shown in employment in the construction field, the number of men employed by heating contractors having shown a gain. However, the payrolls and manhours reported by these contractors showed a decrease over the previous month.

May Building More than Double April

Indicated expenditures for total building construction were 128.6% greater than in April, 1933, according to reports received by the Bureau of Labor Statistics of the U. S. Department of Labor from 761 cities. The increase was far above the usual seasonal trend, since in 1932 the increase from April to May was only 24%. In 1931, May was 19.5% below, and in 1930, 6.1% below April.

The sharpest gain was in non-residential building, which showed an increase of 240.9%, residential building gaining 75.6%. Alterations and repairs rose 31.7%.

Wholesale Prices Up

The building industry and its subdivisions are sharing in the general rise in wholesale prices, according to the price index computed by the Department of Labor. The average of 784 commodities of all kinds, including food, increased from 60.4 in April to 62.7 in May (1926=100). All building materials increased from 70.2 to 71.4, while heating and plumbing goods rose from 59.4 in April to 61.3 in May.

About June 15 the list price of cast-iron boilers and radiators was advanced 10%, which will result in a sharp increase in the price index of heating and plumbing materials in June.

3.9% Gain in Manufactured Gas House-Heating Customers

An increase of 3.9% in the number of house-heating customers on the lines of manufactured gas companies in March, as compared with March, 1932, is reported by the statistical department of the American Gas Association. Gas sales, however, compared with the same month in 1932, showed a decline of 8.8%.

The number of domestic customers, including those having gas house-heating, served by the natural gas companies, showed a drop of 2.4% for March, as compared with last year.

Orders for Air Conditioning Equipment Rise Sharply

New orders for air conditioning and ventilating equipment for May showed a marked gain over the preceding month. The largest jump was that of air washers which showed an increase of 147% over the preceding month, followed by unit heaters which increased 108%. Other increases were: non-ferrous indirect heating surface, 27%; unit ventilators, 92%; propeller fans, 63%; ventilating blowers, 36%.

Air conditioning units for industrial use showed a 4% decrease from April, but a 2% increase over May, 1932.

of its general offices to new quarters at the company's plant, 2005 West Oklahoma Ave., Milwaukee. The change is being made in the interest of improved coordination between administrative and production departments.

Rome Radiation Appoints Representative in Tenn.

Rome Radiation Co., Division of Revere Copper and Brass, Inc., Rome, N. Y., has appointed Charles F. Sexton, 315 Empire Building, Knoxville, Tenn., as its sales representative for the company's line of convectors in the eastern portion of Tennessee.

Buffalo Office of Republic Steel Moves

Republic Steel Corp., Youngstown, Ohio, announces the removal of its Buffalo district sales office to 475 Abbott Road. Thomas B. Davies continues in charge of the office.

Snow New National Radiator Advertising Manager

National Radiator Corp., Johnstown, Pa., has appointed Randall M. Snow as its advertising and publicity manager. Mr. Snow was formerly connected with the *Official Bulletin* of the Heating and Piping Contractors National Association.

Lawson Heads Sturtevant Unit Ventilator Dept.

B. F. Sturtevant Co., Hyde Park, Boston, Mass., has appointed William I. Lawson, formerly general manager of The Buckeye Blower Company, as manager of its unit ventilator department, with headquarters in Boston.

Electric Utilities Consider Air Conditioning

Utility men turned their attention to air conditioning at the first annual convention of the Edison Electric Institute, June 5-8, at the Palmer House, Chicago, when C. E. Michel, Union Electric Light & Power Co., St. Louis, spoke on "Load Building Opportunities in the Air Conditioning Field."

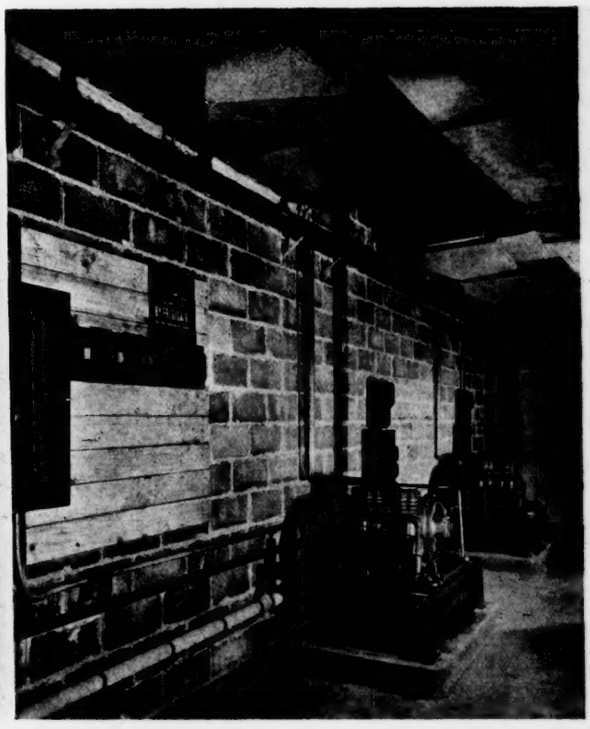
Mr. Michel expressed a belief that the load building potentialities of domestic air conditioning are greater and more imminent than has been generally conceded. He outlined the results of his company's sales activities in the St. Louis market during 1932, pointing out that of the 44 mechanical installations placed in service last year, 16 are in residential buildings, two in industrial, and the rest scattered among restaurants, hotels, theaters, offices, etc. In one of these residences, 3 kw. are required to cool three rooms. A completely conditioned building in the city required 171,990 kw-hr. last year for refrigeration alone, and a theater and hotel dining room used 412,000 kw-hr. and 78,000 kw-hr. respectively, during the same season.

R. H. Tillman, Consolidated Gas, Electric Light & Power Co., Baltimore, followed with a paper in which industrial applications were discussed. He expressed a belief that the more immediate developments will take place in those industries requiring air conditioning for process work.

A paper, "Commercial and Residential Applications," was then presented by Davis M. DeBard, Stone & Webster Service Corp., New York, in which he recommended that the utilities cooperate with manufac-

LITTLE THEATER AT CHICAGO EXPOSITION CONDITIONED BY FRIGIDAIRE

Two of three 10-ton compressors which cool and dehumidify the Little Theater at A Century of Progress are shown at the right. Below is an interior view of the theater, showing the supply grilles in the walls, and the exhaust grilles above the lighting fixtures. This is the first heavy duty air conditioning equipment manufactured by Frigidaire Corporation.



News of the Month

turers of air conditioning equipment and their representatives. W. H. Hodge, Byllesby Engineering & Management Corp., Chicago, concluded the discussion of air conditioning with a paper on the general aspects of the subject, in which he cautioned the power companies to proceed slowly in the matter of promotion until a more thorough survey of load possibilities has been made.

Deficit for Holland Furnace

The report of the Holland Furnace Company for the fiscal year ended March 31, certified by independent auditors, shows a net loss of $2,379,244 after taxes, interest, depreciation, etc. This compares with a net profit of $265,906 for the preceding year.

Dresser Purchases Bryant Heater

S. R. Dresser Manufacturing Co., Bradford, Pa., manufacturer of pipe couplings, clamps, and other pipe line accessories, purchased The Bryant Heater & Manufacturing Co., Cleveland, on June 15.

F. A. Miller and H. N. Mallon, chairman and president, respectively, of S. R. Dresser, will hold similar offices in The Bryant Heater & Manufacturing Company. L. C. Harvey, present sales manager of Bryant, will be vice-president in charge of sales. E. P. Bailey, Jr., returning to Bryant after an absence of three years, will be vice-president in charge of operation.

Cooling in Brewing Subject of Meeting of New York A.S.R.E.

At the final meeting of the New York Section, A.S.R.E., May 25, at the Hotel Whitehall, A. B. Stickney, of Fred Ophuls and Associates, Inc., presented a paper entitled "The Significance of Refrigeration in the Brewery." This was followed by a description of the Lion Brewery by Emil H. Schneider, consulting engineer of the firm of Schneider & Foley, who conducted the members and guests on a tour of inspection through the plant at the close of the meeting.

Officers of the New York Section for the coming year were elected as follows: president, I. E. McFarland; first vice-president, E. C. Soares; second vice-president, C. F. Holske; secretary-treasurer, C. H. Roe.

American Blower Holds Air Conditioning Conference

Plans for marketing steam jet refrigeration, and a discussion of its applications, were major topics on the program of an air conditioning conference held at Detroit, June 22-24, by American Blower Corporation. Representatives of the company from all parts of the country were in attendance. C. T. Morse, president, pointed out the adaptabilities of the steam jet method of cooling water for air conditioning and drinking purposes in metropolitan centers.

A new hydraulic coupling, providing infinite speed ratios with a constant speed drive, also came up for discussion, and considerable attention was directed toward air cleaning and home air conditioning problems.

COMING EVENTS

JULY 25-28, 1933. Annual Convention of the Heating and Piping Contractors National Association, to be held in Chicago. Headquarters at the Hotel Sherman.

SEPTEMBER 25-29, 1933. Fifteenth Annual Convention of the American Gas Association, to be held in Chicago.

FEBRUARY 5-9, 1934. Third International Heating and Ventilating Exposition, to be held in the Grand Central Palace, New York.

Herbert I. Lord

Herbert I. Lord, first vice-president of Detroit Lubricator Company, died in Detroit, May 25.

A graduate of Massachusetts Institute of Technology, Mr. Lord joined the sales force of the American Radiator Company in Boston, and was later transferred to Chicago. He subsequently became first vice-president of Detroit Lubricator, a subsidiary company of the American Radiator & Standard Sanitary Corporation.

NEW CATALOGS

Air Reduction Sales Co., Lincoln Building, New York, has issued a booklet, "The Facts about Welded Piping for Buildings," setting forth the advantages of welded fabrication and illustrated with installation photographs. Standard size, 12 pages.

American Car and Foundry Co., 30 Church St., New York, has issued two bulletins describing air conditioning systems for railroad cars. Standard size, 3 pages each.

American District Steam Co., North Tonawanda, N. Y., has published Bulletin No. 415 devoted to Adsco rotary condensation meters. Operation is described and construction details are illustrated. Instructions for installing, testing, and use of the products are also included. Standard size, 12 pages.

Erskine Copper Radiator Corp., 1 East 42nd St., New York, has issued two pamphlets describing and illustrating Erskine portable electric radiators and all-copper indirect water heaters. Sizes, capacities, and price data are included.

Frigidaire Corp., Dayton, Ohio, has issued "Modern Air Conditioning Equipment by Frigidaire," a booklet containing information for architects, engineers, contractors, and owners, in which installations of the company's equipment for many types of building and commercial establishments are described and diagrammed. Standard size, 30 pages.

Gorton Heating Corp., Cranford, N. J., has issued Bulletin No. 98, describing Surevent equalizing valves for equalizing automatically-controlled and automatically-fired steam heating systems. Standard size, 4 pages.

Hoffman Specialty Co., Inc., Waterbury, Conn., has issued Catalog No. CHS 433, devoted to controlled-heat equipment. Specialties made by this manufacturer for two-pipe steam heating systems are illustrated and described with detailed

specifications. Standard size, 12 pages.

E. F. Houghton & Co., 240 West Somerset St., Philadelphia, has published a wall chart containing references on the care of leather belting. Subjects covered include belt dressing, fastenings, installation, and engineering computations. Size 24 in. × 36 in.; sent by the company without charge.

York Ice Machinery Corp., York, Pa., has issued a catalog describing refrigerating units designed expressly for freon refrigerant. Construction details are explained and illustrated. Standard size, 16 pages. The company has also published Bulletin No. 33190 on York air conditioning equipment. Standard size, 7 pages.

Correspondence

Are Winters Getting Warmer?

EDITOR, HEATING AND VENTILATING:

The article under the above title in the May, 1933, number of HEATING AND VENTILATING was of exceptional interest to me because 12 years ago I wrote an article entitled "Is Our Atmosphere Getting Warmer?" which was published in the October, 1921, issue of HEATING AND VENTILATING, pages 62-63.

By referring back to my article it will be found that I made an attempt to compute the rate of increase of temperature by determining the total amount of heat liberated over the entire world due to the combustion of fuels.

According to Fig. 2 by Nee and Boyden, the average temperature in Boston has increased at the rate of 1° in 21.4 years. Probably that figure applies more or less closely over the entire earth because, quoting myself as stated in my article 12 years ago:

"It would take 54 years for all of the heat, applied at the same rate every year, to raise the temperature of our atmosphere 1°."

The figures used in my ancient article were necessarily rough owing to the unavailability of accurate information. I named the sources in every instance, Elmer C. Hole, editor of "American Lumberman," being one source, and here is a portion of what he said:

"Outside of the United States, very few official statistics can be found and the totals should be regarded as little better than guesses. Yet statistics furnish a basis for some estimates."

I am naturally pleased to note that my guess was only 33 years off. In other words, I was about 40% right.

I would therefore like to make this correction: In my article published in 1921 I estimated the "world's total heat," generated per year, to be 52,370,000,000,000,000 B.t.u. Divide 54 years by 21.4 years and we have a correction factor of 2.52. Multiplying the above estimate by this correction factor we get, 131,800,000,000,000,000 B.t.u.

Let us now go a little farther and reduce this to terms that are more easily visualized—in terms of tons of coal per inhabitant of the earth.

In round figures there are about two billion human beings on this earth. Dividing 131,800,000,000,000,000 by 2,000,000,000 we get 65,900,000 B.t.u. per inhabitant.

Assuming that each pound of coal contains 15,000 B.t.u. and multiplying by 2000 we can say that each ton of coal contains 30,000,000 B.t.u. Dividing this into 65,900,000 we get 2.2 tons of coal burned per inhabitant per year over the entire earth, which is probably not far from the truth. Unquestionably, in the colder regions, the equivalent heat generation per inhabitant is greater than 2.2 tons of coal. In the warm regions it is very much less. However, as an average I believe 2.2 tons is not seriously incorrect.

To make my motive perfectly clear, let me sum up in this way: The generation of heat by the process of combustion over the entire earth, at the rate of 2.2 tons of coal per human being per year, will increase the temperature of the atmosphere 1° every 21.4 years.

W. F. SCHAPHORST

Newark, N. J.

25 Years Ago in

The Heating, Ventilating Magazine

JULY, 1908

AMONG THE PAPERS presented at the semi-annual meeting, A.S.H.V.E., Niagara Falls, N. Y., July 24-25, were "Reason Why the Science of Heating and Ventilating Should Be Observed," by J. D. Hoffman, and "Coefficient of Transmission in Cast-Iron Radiation," by John R. Allen.

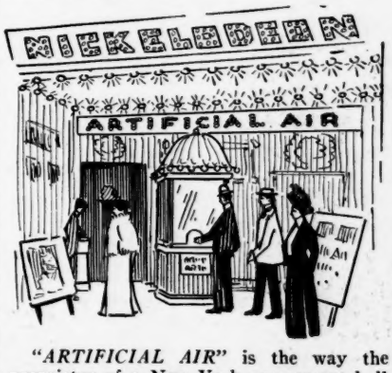
ELECTION of Dwight D. Kimball, New York, and Frank N. Speller, Pittsburgh, to membership in the A.S.H.V.E. was announced at the society's semi-annual meeting.

PRESSED RADIATOR CO., Pittsburgh, Pa., has issued a notice stating that "It has been brought to our notice that certain persons have resorted in a number of instances to the dastardly method of bribing engineers of buildings, where the Kinnear pressed radiators have been installed, to run the pressure up to the point of bursting, and then spreading the report throughout the country that the pressed radiator is a failure. We desire to say that we are in possession of data and facts gathered by detectives which we have employed, and are preparing to bring action against those whom we know to be implicated."

CRANE CO., Chicago, has purchased 30 acres of land in Oakmont, near Pittsburgh, where an additional plant will be built for the manufacture of heating, plumbing, gas, and water supplies.

MEMBERS AND FRIENDS of the National Association of Master Steam and Hot Water Fitters enjoyed an excursion by steamboat to Nantasket Beach as guests of Walworth Manufacturing Co., Boston, at the close of the association's twentieth annual convention, held at Boston, June 15-18, 1908.

SUPERIOR, WIS.—By the end of the summer probably 70% of the 85 school buildings of Douglas County will be equipped with heating and ventilating plants. Under the law, the schools are given special State aid of $50 each per year for three years, provided heating plants are installed, together with other minor requirements.

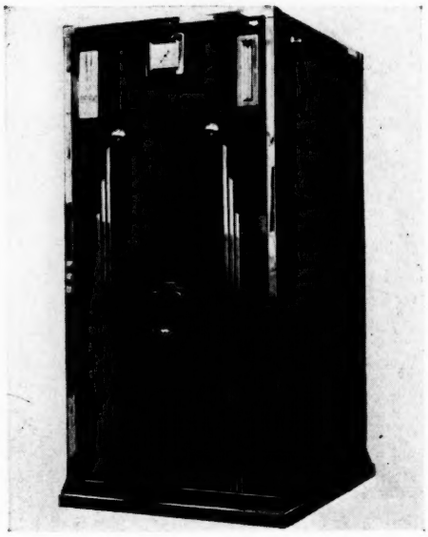


"ARTIFICIAL AIR" is the way the proprietor of a New York amusement hall describes one of the physical comforts offered his patrons.

New Equipment

Torridheet Announces Boiler-Burner Unit

Cleveland Steel Products Corp., Torridheet Division, Cleveland, is marketing a boiler-burner unit for residential heating. Boiler is of the cast-iron sectional type and consists of refractory-lined base, fire-pot, intermediate, and dome sections. Indirect heating surfaces are of the fin type.



Torridheet boiler-burner unit

A Torridheet Model C oil burner, insulated hearth, dual electric pilot, ignition transformer, and wiring box are built into the base section at the factory. The unit is equipped with high and low limit controls, low water cut-off and feeder, and a built-in large capacity water heating coil. Capacity of the boiler is given as 750 sq. ft. of connected load.

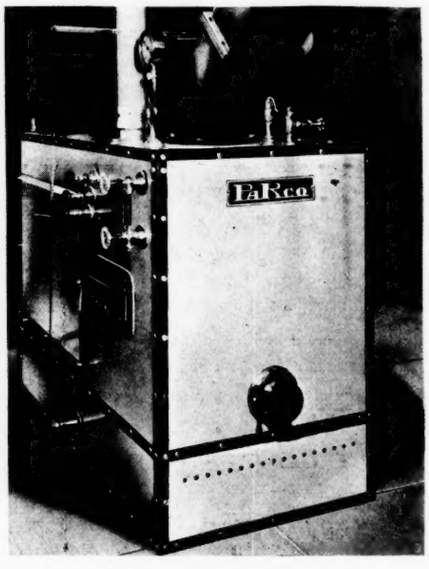
Automatic Coal-Burning Boiler Supplies Steam for Many Uses

An entirely automatic coal-burning steel heating boiler, the Parco Maximatic, has been developed in the shops of The Philadelphia and Reading Coal and Iron Co., 721 Reading Terminal, Philadelphia, and is now on exhibition in a model residence erected by the company at Merion, Pa. In this demonstration installation, the boiler constitutes the center of a household power plant, supplying steam for complete year 'round air conditioning functions, including refrigeration for summer cooling, household refrigeration and drinking water cooling, in addition to heating the domestic hot water and operating a dryer in the laundry.

Chestnut size coal is fed by gravity through an enclosed chute directly from the bin to a grate of unusual design which insures a fire-bed of uniform thickness. Ash removal is accomplished by a thermostatically-controlled electric motor, the entire operation requiring about 1½ min., ordinarily taking place but once in 24 hr., thereby drawing a negligible electric power consumption. The boiler operates on natural draft, and extensive heat absorbing surface with a long fire travel is provided.

When used for heating purposes only, the conventional type of room thermostat regulates the operation of the Parco boiler. In the exhibition installation, where steam is applied to such varied functions, a steam pressure regulator controls the combustion.

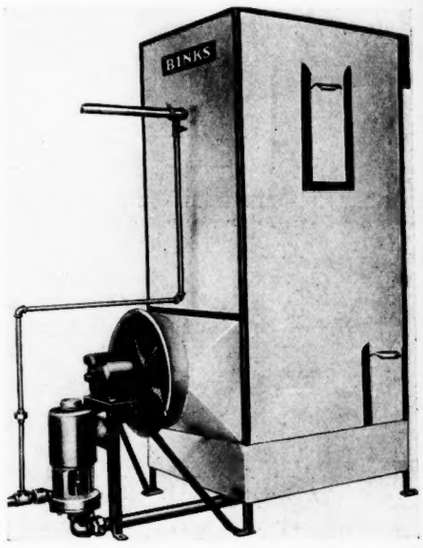
The installed model is encased in chromium-plated steel, although other finishes can be had as desired. The space around the combustion chamber is completely water-jacketed, and the entire combustion chamber and boiler are effectively insulated. Operating efficiencies ranging between 80% and 90% are claimed by the manufacturer.



Parco Maximatic boiler

Forced Draft Cooling Tower for Indoor Installation

Binks Manufacturing Co., 3114 Carroll Ave., Chicago, is manufacturing the Type FD forced draft spray cooling tower for indoor installation. Towers are available in capacities ranging from 5 g.p.m. to 50 g.p.m., corresponding to the condensing water used in refrigerating machines of capacities between 1½ tons to 12 tons.



Binks forced draft cooling tower

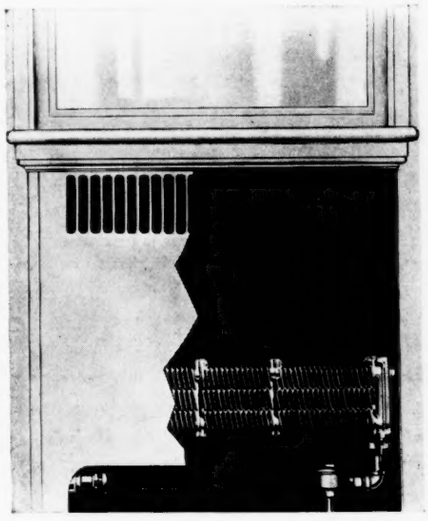
Warm circulating water from the condenser is piped to the cooling tower and discharged downward from "Rotojet" spray nozzles located at the top of the enclosure. A motor-driven fan propels air into the bottom of the tower, and this discharges to the atmosphere at the top, giving counter-flow heat exchange conditions. The water, cooled by evaporation, falls to a reservoir at the bottom of the tower from which it enters the pump suction to be recirculated to the condenser. A float valve in this reservoir controls the valve which lets in make-up water from the city main.

American Radiator Brings Out A Cast-Iron Convector

American Radiator Co., 40 West 40th St., New York, is marketing

the Arco convector, consisting of assembled cast-iron sections and headers united with malleable nipples. It is adapted for steam or hot water heating.

Fins are cast integrally with the cored sections and are spaced to promote a steady and continuous flow of air throughout the entire surface. All contacting surfaces are machine ground, and individual tie bolts hold the sections together at each nipple port. The large steam chamber in the cast-iron finned sections provides ample storage capacity for steam or hot water, resulting in a long carry over output, especially when installed with an



Arco convector in window recess

automatically-controlled plant.

Tappings in the headers give a wide choice of piping connections and make possible exceedingly compact arrangements where space is limited. Units are available in four widths, 3¾ in., 5⅝ in., 7⅝ in. and 9½ in., and in lengths varying in 2½ in. steps above 13 in. Catalogs are available from the manufacturer giving ratings, and describing and illustrating enclosures.

G. E. Adds Smaller Boiler-Burner Unit to Line

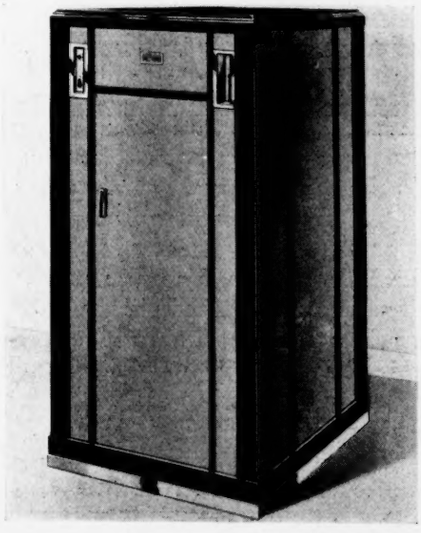
General Electric Co., Schenectady, N. Y., has announced an oil-burning boiler similar in design and operation to the larger model brought out last year, but having approximately one-half the capacity. Maximum rated output is 133,000 B.t.u. per hr., equivalent to 555 sq. ft. of direct steam radiating surface. The unit is suitable for use in steam or hot water systems, and can be used in conjunction with the G.E. air conditioner in forced-air systems. The burner has a maximum oil rate of 1.25 g.p.h. and a minimum rate of 0.7 g.p.h.

Timken to Market Boiler-Burner Combination

A combined oil burner and boiler unit for residential heating has been announced by The Timken Silent Automatic Co., 100-400 Clark Ave., Detroit. The capacity is stated to be 750 sq. ft. of steam or 1200 sq. ft. of hot water radiating surface.

Boiler is of the vertical type with oval fire chamber. It is built up of four cast-iron sections incorporating two horizontal flues with multi-surface gas passages, giving a long three-way fire travel with extended fins for maximum absorption. All joints between sections and at doors are ground gas tight. Domestic hot water is obtained from submerged copper coils, and boiler is equipped with an automatic water feeder.

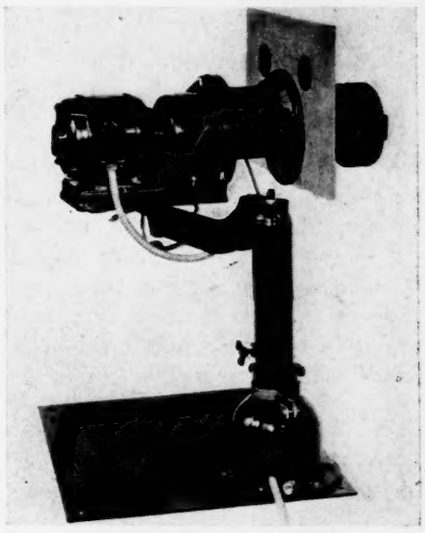
Burner is of the wall flame rotary type, with gravity feed from a constant level chamber and controlled by dual magnetic valves. It is driven by a 1/20-hp. capacitor type motor. Either No. 1 or No. 2 furnace oil can be burned, and the normal operating rate is 11 lb. per hr. The fuel is distributed to the flame rim by centrifugal force. Complete automatic control is standard equipment with the outfit, and the unit is enclosed in a heavy sheet metal cabinet, having a smooth exterior surface and finished with stainless steel trim. Heavy reinforced mineral wool insulation lines the inside of the casing.



Timken burner-boiler combination

Kelvinator Has Variable Flame Oil Burner

Kelvinator Corp., Detroit, Mich., has entered the oil burner field with the announcement of a burner for residential heating. The burner is of the gun type and features a variable flame regulated by a hydraulic control system.



Kelvinator oil burner

Mounted on a pedestal outside the boiler, the burner head swings in and out of the furnace through the fire-door opening, leaving the grates undisturbed and available for use as an incinerator. The burner remains in continuous operation when heat is needed, but its intensity is automatically adjusted to the exact heating requirements by a hydrostatic control located in the living quarters. This device consists of a closed container carrying a volatile liquid, variations of pressure in which are conveyed through a tube to a bellows which actuates the oil regulating needle valve. This metered oil traverses an air metering device which proportions the air supply to maintain

New Equipment

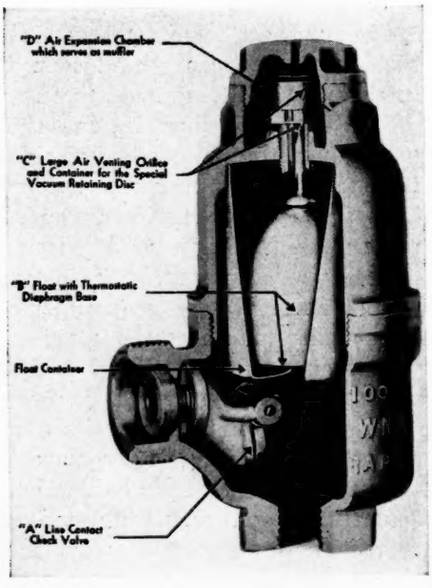
correct combustion conditions. An adjustment screw on the temperature selector sets it for any desired temperature. This continuous operation is said by the manufacturer to show an advantage over intermittent operation with respect to both temperature regulation and economy of oil and power consumption, since burner and motor can be smaller.

Burner is constructed so that the flame burns in suspension, directing the completely burned gases against the upper part of the boiler.

Vapor-Vacuum System Requires No Pump

Brownie Co., Inc., Belleville Turnpike, North Arlington, N. J., has developed a vapor-vacuum heating system which avoids the use of traps, pumps, and other boiler room accessories. The manufacturer recommends it as particularly adaptable to small plants in residences, stores, and other small commercial and industrial buildings, and claims for it all the advantages of the more elaborate systems, including uniform steam distribution and quick heating.

The system centers around the Brownie combined trap and air vent which is connected into the return of each radiator. This trap functions to drain the radiator of condensation regardless of temperature and pressure, to vent air and other non-condensable gases at the radiator at any pressure above atmospheric, and prevent the re-infiltration of air into the system when operating under a vacuum when the fire is banked. In addition, it permits the return of condensate to the boiler under all conditions of vacuum or pressure without the use of additional boiler room equipment.


"D" Air Expansion Chamber which serves as muffler
"C" Large Air Venting Orifice and Container for the Special Vacuum Retaining Disc
"B" Float with Thermostatic Diaphragm Base
Float Container
"A" Line Contact Check Valve

Brownie radiator trap

Air, condensation, and steam enter the trap through the check valve, A, having a raised seat providing line contact insuring free action. The annular orifice of this check valve is lower than the inlet, insuring complete discharge of condensate which flows by gravity into the return. A float, B, having a thermostatic base, is enclosed in a container having an orifice at top and bottom. When sufficient pure steam enters the float container, the thermostatic diaphragm expands to close the venting valve, which opens again when an accumulation of air or other non-condensable gases causes the temperature to fall.

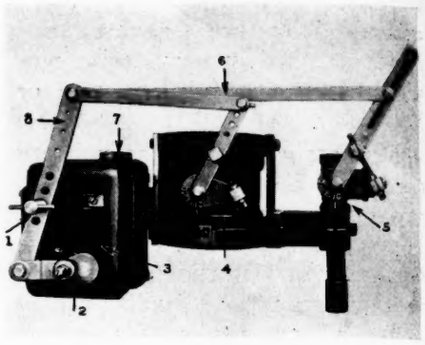
A vacuum retaining disc of unusual design is located at C, and the air expansion chamber, D, serves as a muffler to provide for quick and noiseless venting.

When steam is generated at the boiler, it will start to flow immediately to the radiators, and only a few ounces of pressure are required to vent the system and establish circulation uniformly to all radiators. If insufficient steam enters the return, a pressure drop is established which opens the equalizer to admit steam to the return to maintain a pressure drop of approximately 2 oz. between supply and return. When a radiator is turned off, an exceedingly high vacuum is maintained in it until the valve is opened, when steam will rush in instantly, even though the entire system may be operating at a vacuum.

The system is said to be well adapted for use with fan unit heaters, and with concealed convection heaters of the non-ferrous type.

Motor-Operated Controller

Automatic Temperature Control Co., Inc., 34 East Logan St., Philadelphia, has announced the Type 2 motor-driven controller for operating a valve, damper, or rheostat to control the flow of air, gas, oil, steam, etc. Control is available in both one and two-position models.



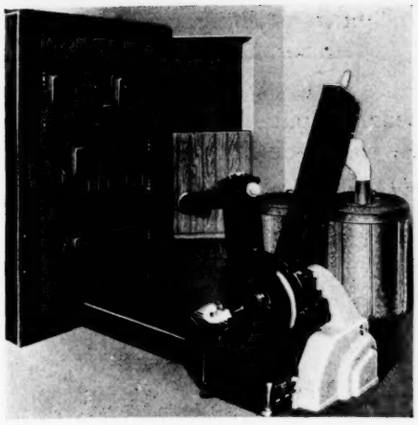
A.T.C. motor-operated controller regulating air and fuel valve for combustion control

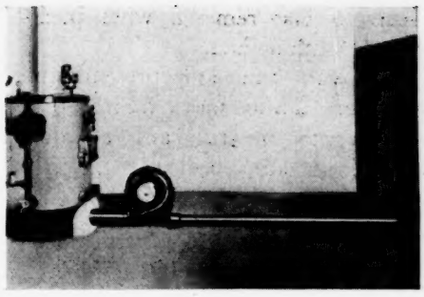
For automatic operation, an actuating instrument having high and low contacts capable of handling, direct or through relays, 3/10 ampere at 110 volts, should be used. Contact at the actuating instrument causes a sustaining switch in the controller to close and maintain the circuit until the controller completes its opening or closing stroke, when the limit switch opens the motor circuit. Valves may be provided with a minimum adjustment feature where desired, permitting any desired minimum setting up to 50% of valve capacity.

Stoker Conveys Fuel from Bin

Completely automatic heat is offered by Motorstoker Corp., 290 Hudson St., New York, with its Series 2AF anthracite stoker, which conveys fuel directly from the bin to the furnace in addition to removing the ashes and depositing them dustlessly in a receptacle. The stoker is made in seven sizes, ranging in capacity from 20 lb. to 100 lb. per hr.

This equipment is exactly similar in principle and operation to the line of Motorstokers formerly designated Series 2, with the exception of the elimination of the hopper and the substitution in its place of a screw-type conveyor which delivers coal from the bin directly to the fuel-charging mechanism. This conveyor screw is driven through a





(Left) Series 2AF Motorstoker
(Above) Series 5AF20 Motorstoker

positive engaging ratchet and pawl operated by a rocker arm connected by a ball and socket joint to a crank at the rear of the transmission case, permitting a wide variety of relationships between the coal-bin, stoker, and boiler. The conveyor can thus be led off in any direction around a complete circle from the stoker, and in addition can be elevated or lowered at any angle up to 15° above and below horizontal.

Series 5AF20, the straight line model, is an entirely new development as to layout, although the stoking principle of other models by this manufacture is adhered to. This machine likewise draws the fuel from the bin instead of from a hopper, but the ash removing feature is not included, and the conveyor and the charging tube are in exact alignment, both screws being driven from opposite ends of the same shaft.

Fan and driving motor are mounted on the base cover plate, and a worm gear reduction set within the base is driven by a V-belt. Coal from the bin is delivered into a pocket where it is picked up by the main stoker screw and driven into the burner in the conventional way. The straight line series is available in the same range of capacities as the Series 2AF.

Micrometer Adjustment Regulator for Welding

A micrometer adjustment regulator for gas pressures suitable for a wide range of welding and cutting operations has been announced by The Alexander Milburn Co., 1416 West Baltimore St., Baltimore, Md. A dual adjustment is employed, comprising a fine micrometer adjusting key housed within and operating separately from the main regulator. The regulator has two compression springs, one within the other, operating a removable, non-corrosive metal diaphragm.

The main key operates through the standard key for rough adjustments over the entire range of pressures, and the micrometer key regulates the fine bronze spring which enables the operator to secure a range of from 0 lb. to approximately 5 lb. Inlet connections are removable and interchangeable.

New Temperature Control Anticipates Heat Loss

Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., has developed the Thermochron, a control system for heating plants which combines time and temperature functions to make possible the anticipation of temperature changes to provide for the starting and stopping of the automatic firing device to maintain an even temperature without wasteful and annoying over-shooting or under-heating.

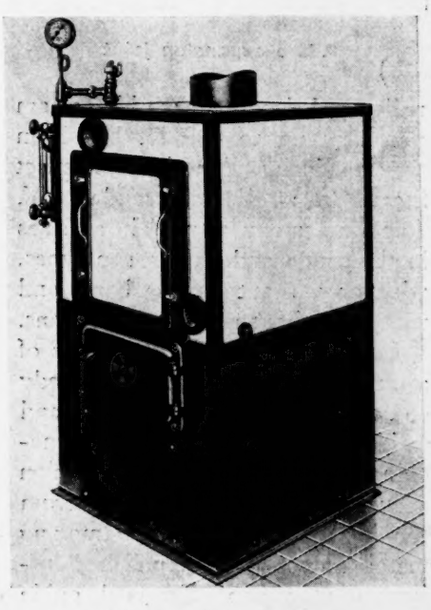
Similar in appearance and principle to the standard clock thermostat manufactured by this company, the Thermochron is an electric clock control so constructed that a fraction of a degree drop in temperature places the mechanical firing equipment in operation for a period of just sufficient duration to bring the room up to the desired temperature without overheating. Any fractional degree of heat loss occurring since the previous operation of the burner is sufficient to place it in operation, but unless there is a drastic heat loss the burner can operate but once each half hour.

This operation is achieved through the use of a movable coil and blade assembly, controlled by a synchronous motor and cam, which move the blade toward and away from the contacts in regular 30-min. cycles. The plant, therefore, constantly provides heat directly in proportion to the rate and amount of heat lost from the building, without stratification.

Peerless Oil-Burning Boiler Announced

A line of cast-iron sectional boilers expressly designed for oil firing has been announced by The Eastern Foundry Co., The Peerless Heater Company Div., Boyertown, Pa. These boilers are designated the Peerless Model AO, and are manufactured in seven sizes ranging in rated capacity from 890 sq. ft. to 2775 sq. ft. of equivalent direct steam radiating surface. Both steam and hot water models are available.

Combustion chamber in each size of boiler is proportioned according to the combined areas of the heating surfaces available. Fire travel is staggered, and in a generally upward direction, and sections are de-



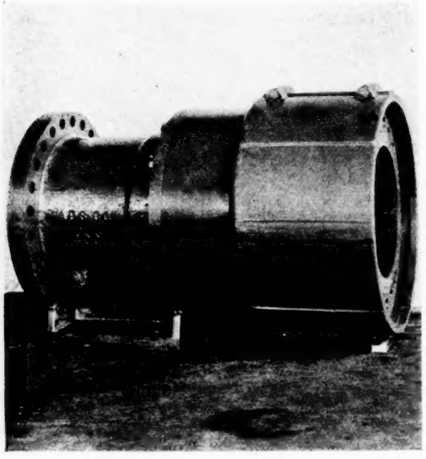
Peerless oil-burning boiler

signed to provide for rapid circulation of water. Tappings are provided for connection to domestic water heater.

An attractively finished heavily insulated jacket encloses the upper portion of the boiler, and insulated cleanout doors permit easy access to the flues for cleaning heat-absorbing surfaces. Combustion space is lined with firebrick, and an inspection door with peep-hole permits observation of flame. Burner installation is made through a removable plate.

Expansion Joint Developed for High Pressures

A complete line of slip expansion joints of the internally-exter-



Adsco expansion joint

nally guided type for working steam pressures up to 400 lb. has been developed by American District Steam Co., North Tonawanda, N. Y. Joints are manufactured in all sizes in the single and double slip types, with or without anchor base, and with or without service connections.

Internal guide feature consists of a ring securely fastened to the body end of the slip. Both guide ring and inside of the joint body are machined to a close fit and the design is such as to keep the slip free from the joint body, preventing moving metal contact with the polished surface of the slip. External guide consists of a hood, made in two pieces for easy removal when packing the stuffing box.

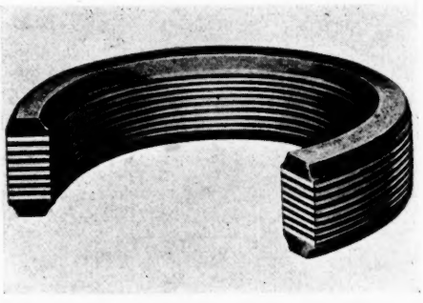
An inward limit stop prevents the slip from taking more than a predetermined traverse, and an outward limit stop prevents the slip from pulling out when the pipe contracts. A relief in the outward limit stop at the bottom of the guide hood provides for the removal of dirt and foreign matter as the guide flange moves to the contracted position.

In addition to the flanged joint, either or both ends may be provided with beveled ends for welding connection to the pipe line. It can be furnished for almost any traverse.

Laminated Packing Developed for Yarway Seatless Blow-Down Valves

A new form of laminated packing, consisting of several stainless steel rings with long fiber asbestos packing compressed between them, has been developed by Yarnall-Waring Co., Chestnut Hill, Philadelphia, for use in Yarway seatless blow-off valves for high-pressure applications. At the time of assembly the material is compressed and heat-treated, rendering the ring suitable for use with steam at extremely high pressure and temperature.

These rings have been successfully subjected to blow-down tests at various steam pressures ranging from 450 lb. to 2100 lb., in which the valves were throttled, constituting conditions more severe than those encountered in normal operating service. The manufacturer states that these tests have indicated that the new packing has a service life six times longer than the packing formerly used, and that no evidence of wire drawing or breakdown of the ring was apparent.

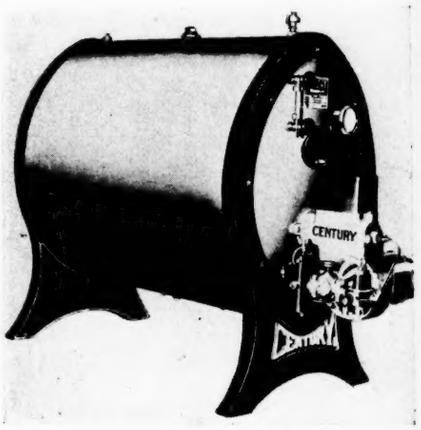


Laminated packing ring in Yarway seatless blow-off valve

Century Announces Boiler-Burner Combination

Century Engineering Corp., Cedar Rapids, Iowa, displayed its new boiler-burner unit for the first time at the American Oil Burner Association exposition at Chicago. The unit is available in two models having capacities of 500 sq. ft. and 900 sq. ft. of steam radiator surface, respectively.

Unit is fully automatic, being equipped at the factory with a complete set of controlling devices including stack switch, aquastat, combination pressure, temperature and altitude meter, gauge glass, and safety valve. A built-in refractory chamber is provided, and a domestic hot water coil of sufficient capacity to provide summer and winter hot water without storage tank is included.

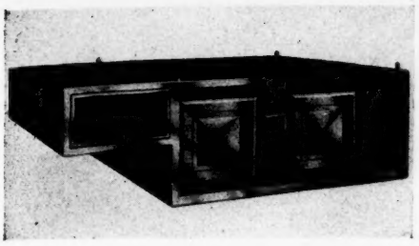


Century boiler-burner unit

Buffalo Forge Conditioner Cools and Heats

Buffalo Forge Co., Buffalo, N. Y., has introduced the Comfort Conditioner, a new unit for room cooling and heating. The unit is adapted primarily to restaurant and office use, and is suitable for stores, auditoriums, and similar applications.

Two extended surface copper coils are provided—one for steam or hot water heating, and the other for cold water or refrigerant. Quiet multiblade type fans, motor-driven through a V-belt, circulate the air. Units are fully enclosed in a non-sweating, sound insulating casing with neatly trimmed metal angles and corners. Discharge outlets are



Buffalo Forge Comfort Conditioner

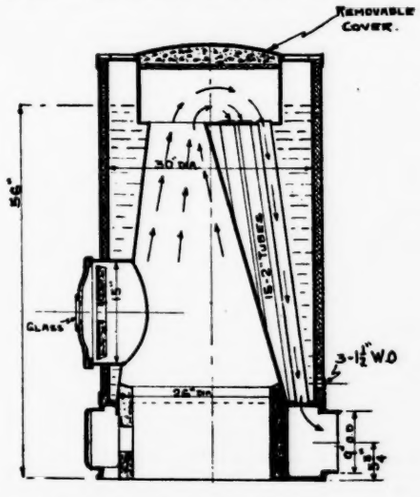
of sound absorbing design.

The unit is made in three sizes, having refrigerating capacities of 2, 4, and 6 tons. Heating coils have a heat transmission range of from 77,500 B.t.u. to 232,000 B.t.u. per hr.

Titusville Designs Oil-Burning Boiler

A welded steel boiler of the double-pass return tubular, downdraft type designed expressly for burning oil has been announced by The Titusville Iron Works Co., Titusville, Pa. It is manufactured in two sizes, having capacities of 500 sq. ft. and 800 sq. ft. of equivalent direct steam radiator surface, and is available for both steam and hot water systems. The boiler is to be known as the Ti-cone.

An unusual design is incorporated, giving a large combustion space with an extensive radiant heat absorbing surface. Fire travel progresses upward to the top of the conical combustion chamber from which it is passed downward through tubes to the smoke-pipe connection at the bottom. The manufacturer states that either a rotary type or gun type oil burner may be used with equal satisfaction.



Titusville Ti-cone oil-burning boiler

A baked enamel finished jacket, lined with rock wool, encloses the boiler. A domestic hot water heater is included.

Thermostat Resists Corrosion

A corrosion-proof duct-type thermostat for use in air conditioning systems has been developed by the Barber-Colman Co., Rockford, Ill.

Corrosion-proof duct thermostat

All parts of the control which may be exposed to moisture or water vapor are of phosphor-bronze with the exception of the sensitive element, which is thermostatic bimetal.

It is designed for low-voltage, three-wire circuits, and is available in the standard ranges.

Asbestos-Cement Ducts Used in Great Britain

Asbestos-cement ventilating ducts have been introduced in Great Britain under the trade name Everite, by Asbestos Cement Building Products Ltd., Trafford Park, Manchester.

This material possesses the advantage of resistance to corrosion in addition to lightness, adequate strength, and minimum of upkeep. It is said to have found considerable application in the British Isles in the ventilating systems of industrial plants and large laboratories where noxious and corrosive fumes are extracted from the buildings. For this purpose, the asbestos-cement material is given an anti-acid treatment to render it impervious to the attack of acid fumes. Roof ventilators and extractors constructed of the same material are also in use.

Standard Engineering Works Markets Ice Room Cooler

Standard Engineering Works, 4339 Duncan Ave., St. Louis, is manufacturing the Chilly Air room cooler, utilizing cracked ice as refrigerant.

Unit is enclosed in a sheet metal cabinet finished in either green or brown lacquer. Four galvanized containers, each holding a capacity of from 50 lb. to 60 lb. of cracked ice, are suspended within the cabinet. A small motor-driven fan draws air in at the bottom, passes it over the ice-filled containers, and discharges it back into the room through the grille at the top. Condensation is drained into a pan at the bottom. A single charge of ice will suffice for about 8 hours of operation when the temperature ranges between 90° and 95°, and it is claimed that the temperature will be lowered 10° to 15° with a reduction of relative humidity of from 15% to 20% in a room containing approximately 2250 cu. ft. of space. Current consumption is given as 40 watts, at 110 volts a.c.

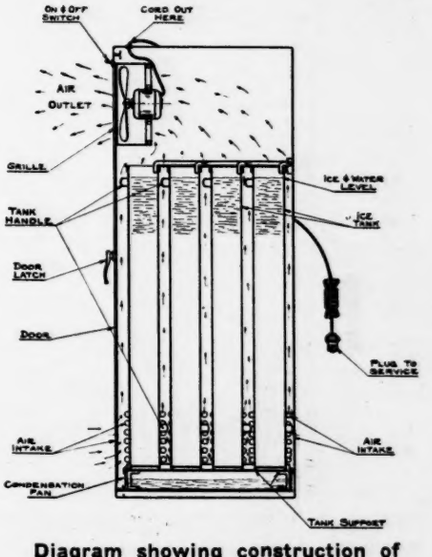


Diagram showing construction of Chilly Air cooler

Degree-Days for Season 3% Below Normal, but 16.4% Above Last Season

(Percentages below indicate increase or decrease in degree-days for this season, Sept. 1 to May 31, compared with normal)

EAST	
New York	—10.7%
Philadelphia	—13.6
Boston	—14.1
Buffalo	— 8.0
Baltimore	— 6.1
Pittsburgh	— 3.5
MIDDLE WEST	
Chicago	— 4.1%
St. Louis	— 2.9
Kansas City	— 8.1
Minneapolis	+ 0.2
Cincinnati	+ 2.3
Cleveland	—12 3
Detroit	— 6.2
Indianapolis	— 1.0
Louisville	+ 2.2
Des Moines	+ 0.3
SOUTH	
New Orleans	+ 6.8%
Atlanta	—2.4
Birmingham	+ 2.6
Memphis	+ 4.1
FAR WEST	
Denver	+ 2.4%
Seattle	+ 1.3
San Francisco	+ 2.8
Los Angeles	— 2.9

THE number of degree-days for the heating season of 1932-33 for the 24 cities for which records are kept by HEATING AND VENTILATING is running on the average 3% below normal, but 16.4% above the season of 1931-32. The figures cover the period from September 1 to May 31. The comparisons with normal and with last year are shown in the columns to the left and right, respectively.

As compared with last year, practically the whole country shows fuel consumption running higher for the season. Exceptions are the Pacific Coast cities, San Francisco, Seattle, and Los Angeles. The greatest increase over last year is shown in New Orleans, Birmingham, and Atlanta. Eastern cities are running from 2% to 16.6% above last year, while the cities in the Middle West indicate a higher fuel consumption this season than last by 8.2% to 27.1%, the latter being the gain for St. Louis.

Comparing the figures with normal, all of the Eastern centers are below this year, with Southern and Far Western cities about normal and Middle Western cities showing mixed figures.

Although May ordinarily closes the heating season, figures will be published next month showing the June degree-days, as the early part of this month occasionally totals some degree-days in the colder climates. As this is written New York has experienced three chilly days in June, with many buildings operating their heating plants.

Degree-days for May, together with totals for this season, last season, and normal, and with fuel consumption data for May, are shown below.

(Percentages below indicate increase or decrease in degree-days for this season, Sept. 1 to May 31, compared with last year)

EAST	
New York	+ 8.2%
Philadelphia	+ 12.1
Boston	+ 2.0
Buffalo	+ 6.4
Baltimore	+ 16.6
Pittsburgh	+ 10.7
MIDDLE WEST	
Chicago	+ 15.5%
St. Louis	+ 27.1
Kansas City	+ 17.0
Minneapolis	+ 13.3
Cincinnati	+ 18.0
Cleveland	+ 8.2
Detroit	+ 12.5
Indianapolis	+ 17.2
Louisville	+ 21.4
Des Moines	+ 14.2
SOUTH	
New Orleans	+ 66.5%
Atlanta	+ 30.2
Birmingham	+ 39.1
Memphis	+ 38.0
FAR WEST	
Denver	+ 7.2%
Seattle	—0.3
San Francisco	—4.7
Los Angeles	—1.7

Degree-Days and Unit Fuel Consumption—May, 1933

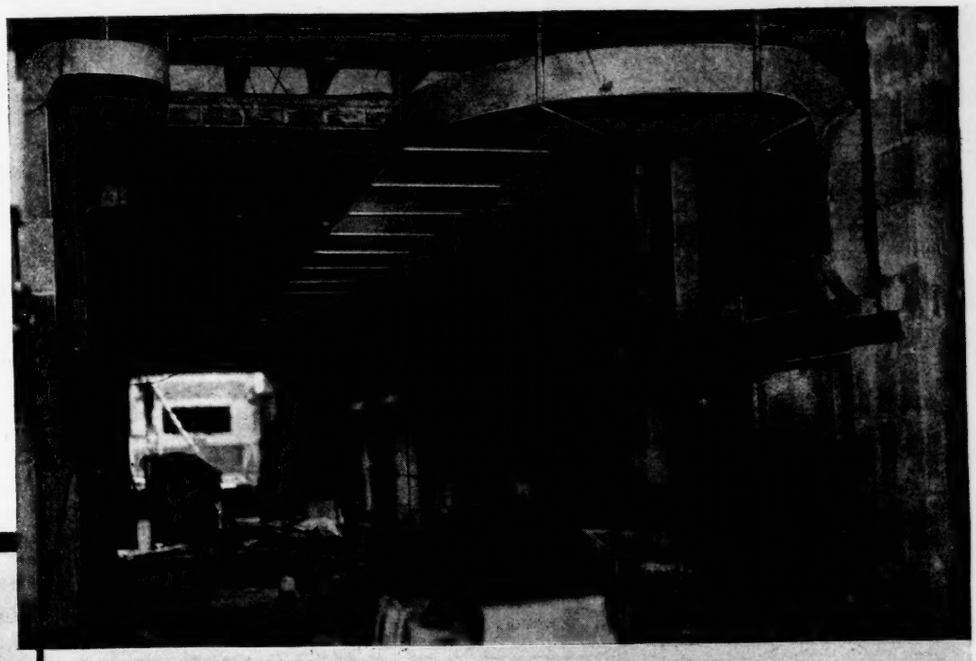
	Atlanta	Baltimore	Birmingham	Boston	Buffalo	Chicago	Cincinnati	Cleveland
Degree-days for May, 1933.....	5	84	1	159	287	199	70	181
Degree-days, Sept. 1, '32 to May 31, '33.	2821	4058	2470	5193	6265	6057	4811	5412
Degree-days, Sept. 1, '31 to May 31, '32.	2165	3479	1776	5093	5889	5243	4076	5004
Degree-days, Sept. 1 to May 31, Normal.	2891	4533	2408	6045	6810	6315	4702	6174
Lb. coal per sq. ft. rad., May, 1933.....	0.040	0.672	0.008	1.272	2.296	1.592	0.560	1.448
Gal. oil per sq. ft. rad., May, 1933.....	0.003	0.058	0.001	0.109	0.197	0.136	0.048	0.124
Cu. ft. gas per sq. ft. rad., May, 1933....	0.48	8.06	0.10	15.26	27.55	19.10	6.72	17.38

	Denver	Des Moines	Detroit	Indianapolis	Kansas City	Los Angeles	Louisville	Memphis
Degree-days for May, 1933.....	324	177	194	93	109	160	43	15
Degree-days, Sept. 1, '32 to May 31, '33.	6012	6391	6089	5242	4874	1461	4273	3070
Degree-days, Sept. 1, '31 to May 31, '32.	5606	5595	5411	4456	4168	1486	3521	2223
Degree-days, Sept. 1 to May 31, Normal.	5873	6373	6494	5297	5302	1504	4180	2950
Lb. coal per sq. ft. rad., May, 1933.....	2.592	1.416	1.552	0.744	0.872	1.280	0.344	0.120
Gal. oil per sq. ft. rad., May, 1933.....	0.222	0.121	0.133	0.064	0.075	0.110	0.029	0.010
Cu. ft. gas per sq. ft. rad., May, 1933....	31.10	16.99	18.62	8.93	10.46	15.36	4.13	1.44

	Minneapolis	New Orleans	New York	Philadelphia	Pittsburgh	St. Louis	San Francisco	Seattle
Degree-days for May, 1933.....	235	....	119	83	115	68	323	357
Degree-days, Sept. 1, '32 to May 31, '33.	7867	1093	4775	4196	5054	4453	2757	4778
Degree-days, Sept. 1, '31 to May 31, '32.	6943	656	4414	3744	4566	3581	2894	4762
Degree-days, Sept. 1 to May 31, Normal.	7851	1023	5348	4855	5235	4585	2681	4716
Lb. coal per sq. ft. rad., May, 1933.....	1.880	....	0.952	0.664	0.920	0.544	2.584	2.856
Gal. oil per sq. ft. rad., May, 1933.....	0.161	....	0.082	0.057	0.079	0.047	0.221	0.245
Cu. ft. gas per sq. ft. rad., May, 1933....	22.56	....	11.42	7.97	11.04	6.53	31.01	34.27

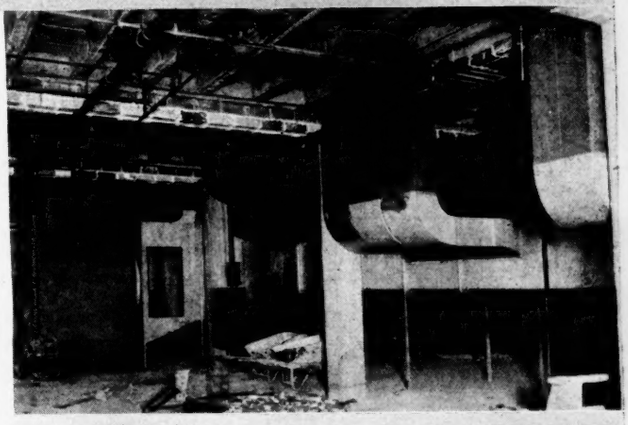
Fuel consumption figures given above are based on certain conditions, and for other conditions corrections must be made. The figures assume the use of steam radiators emitting 240 B.t.u. per sq. ft. per hr., a system operating at 100% efficiency, and radiators calculated for maintaining 70° in zero weather. Heating values assumed for the fuels are 12,000 B.t.u. per lb. for coal, 1000 B.t.u. per cu. ft. for gas, and 140,000 B.t.u. per gal. for oil. To correct for other heating values, efficiencies, and design conditions, follow the method explained in the "Heating and Ventilating Degree Day Handbook."

A ventilating job Noteworthy for its Thoroughness . . . . . with INLAND SHEETS



Exhaust ducts will supply each individual locker in the New Trier High School, Winnetka, Illinois

INLAND OPEN HEARTH STEEL



One of the exhaust fan units

INLAND STEEL SHEETS are being used in the ventilating system of the New Trier High School in the North Shore Chicago suburb of Winnetka, Illinois. It will be one of the largest school buildings in the country.

The high standard set for the installation is indicated by its health-guarding thoroughness. Even the lockers are directly connected to ducts. A total of 155,000 C.F.M. of air will be supplied.

However high your standards may be, Inland experience, Inland equipment, Inland control of quality from mine to you will meet those standards. Consult Inland on all your sheet steel requirements. INLAND STEEL COMPANY, 38 So. Dearborn St., Chicago, Ill.

INLAND STEEL

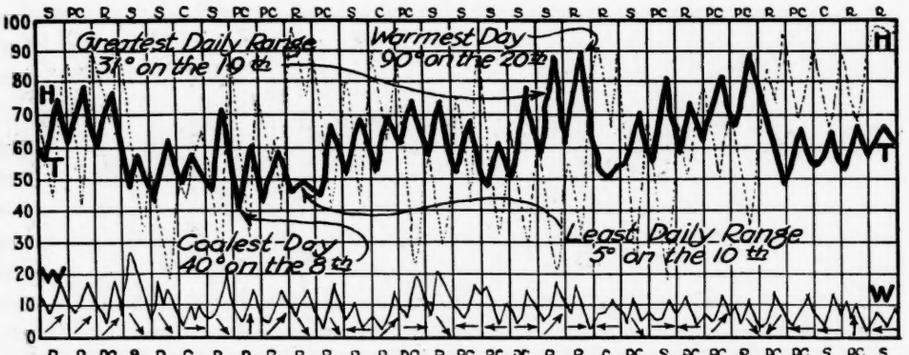
ABLE SERVANT OF THE CENTRAL WEST

Sheets Strip Plates Bands Structurals Piling

Rails Track Accessories Bars Rivets Billets

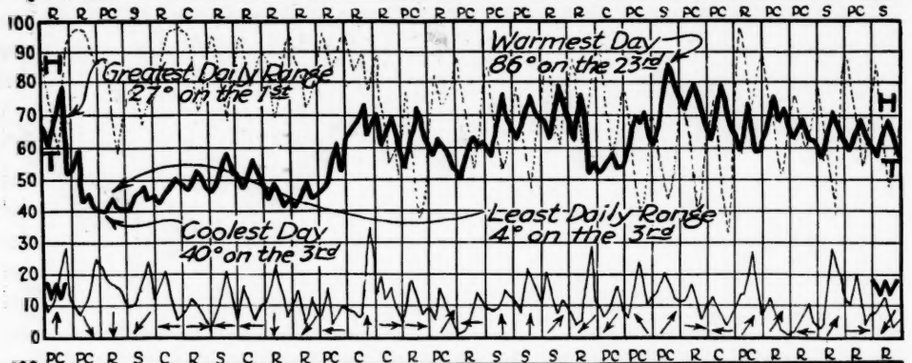
THE WEATHER FOR MAY, 1933

Plotted from records especially compiled for HEATING AND VENTILATING by the U. S. Weather Bureau. Heavy curves (T), temperatures in deg. F.; dotted lines (H), per cent relative humidity, from readings at 8 a.m., noon, and 8 p.m., except for New York, which shows hourly readings. Light lines (W), wind velocity in m.p.h. Arrows indicate prevailing wind directions. S—clear; PC—partly cloudy; C—cloudy; R—rain; Sn—snow.



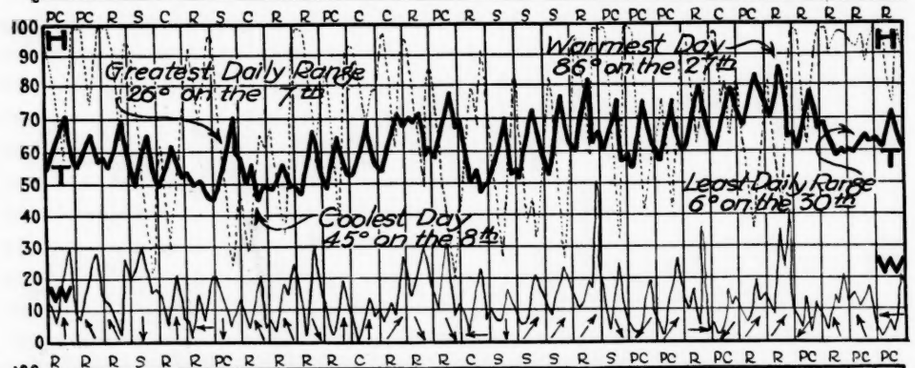
Boston

Mean temp. for month, 61.6°; aver. wind velocity, 8.6 m.p.h.; prevailing direction of wind, S.W.



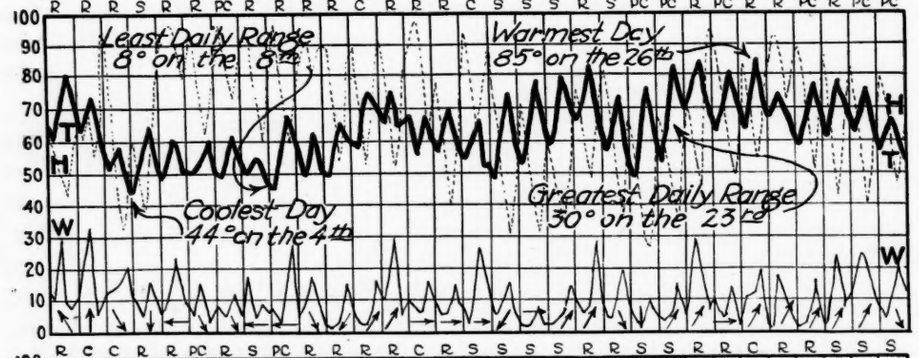
Chicago

Mean temp. for month, 60.0°; aver. wind velocity, 10.8 m.p.h.; prevailing direction of wind, E.



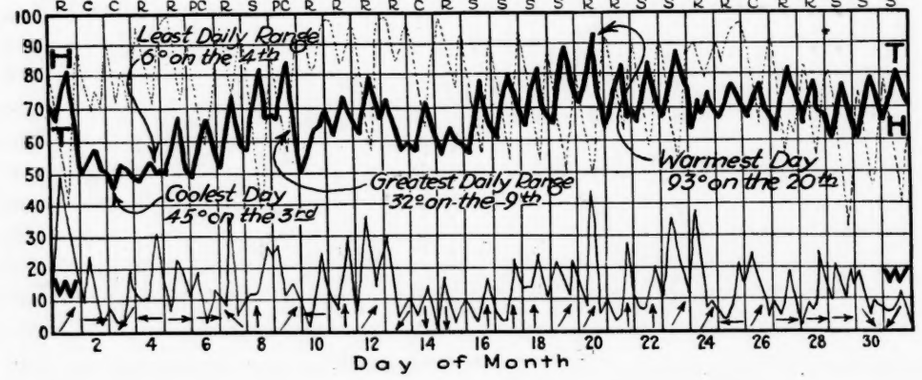
New York

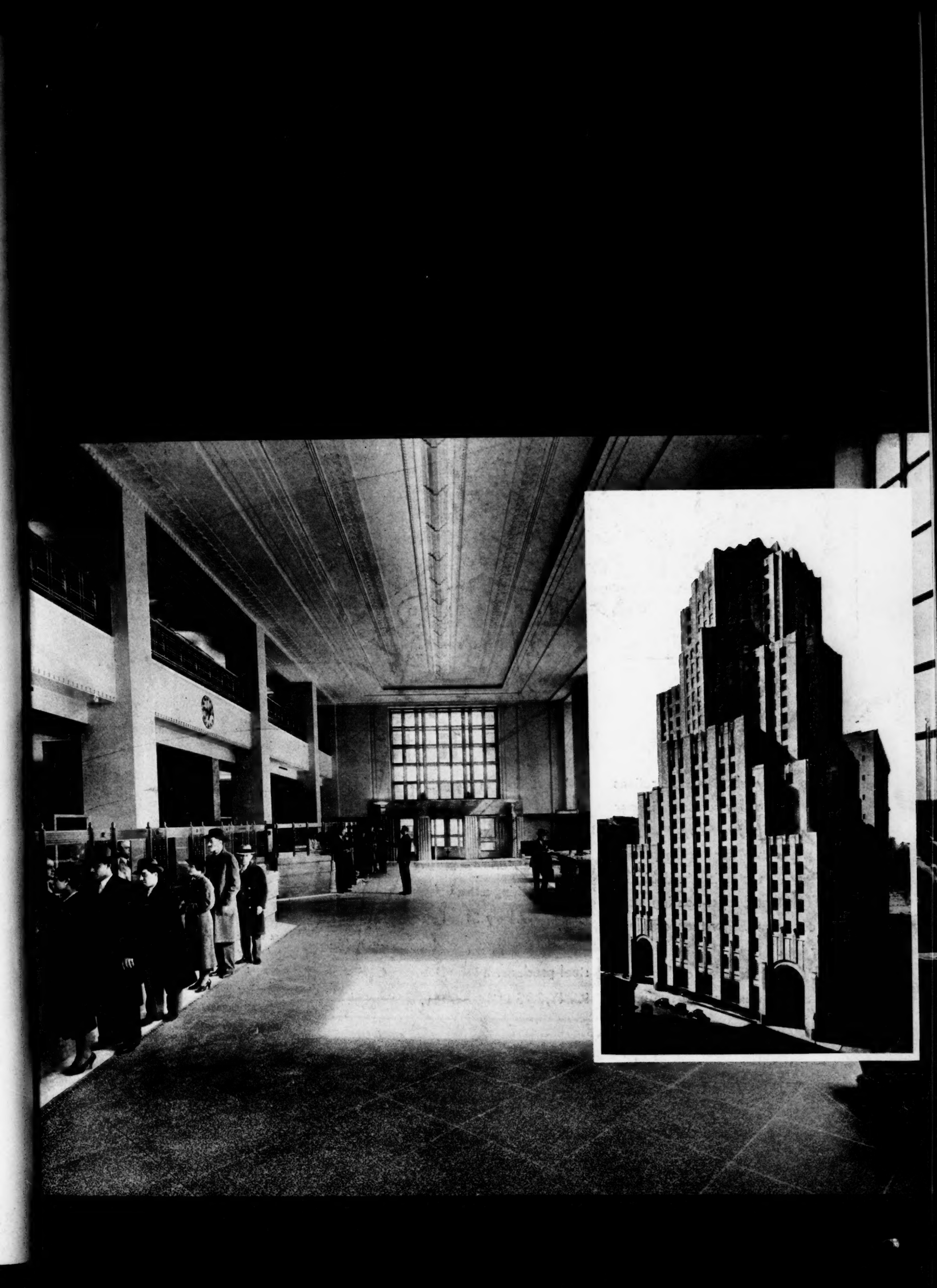
Mean temp. for month, 62.8°; aver. wind velocity, 12.2 m.p.h.; prevailing direction of wind, S.W.



Pittsburgh

Mean temp. for month, 63.5°; aver. wind velocity, 9.3 m.p.h.; prevailing direction of wind, S.W.


Least Daily Range 6° on the 14th
Coolest Day 45° on the 3rd
Greatest Daily Range 32° on the 9th
Warmest Day 93° on the 20th
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30
Day of Month

St. Louis

Mean temp. for month, 67.2°; aver. wind velocity, 12.6 m.p.h.; prevailing direction of wind, S.